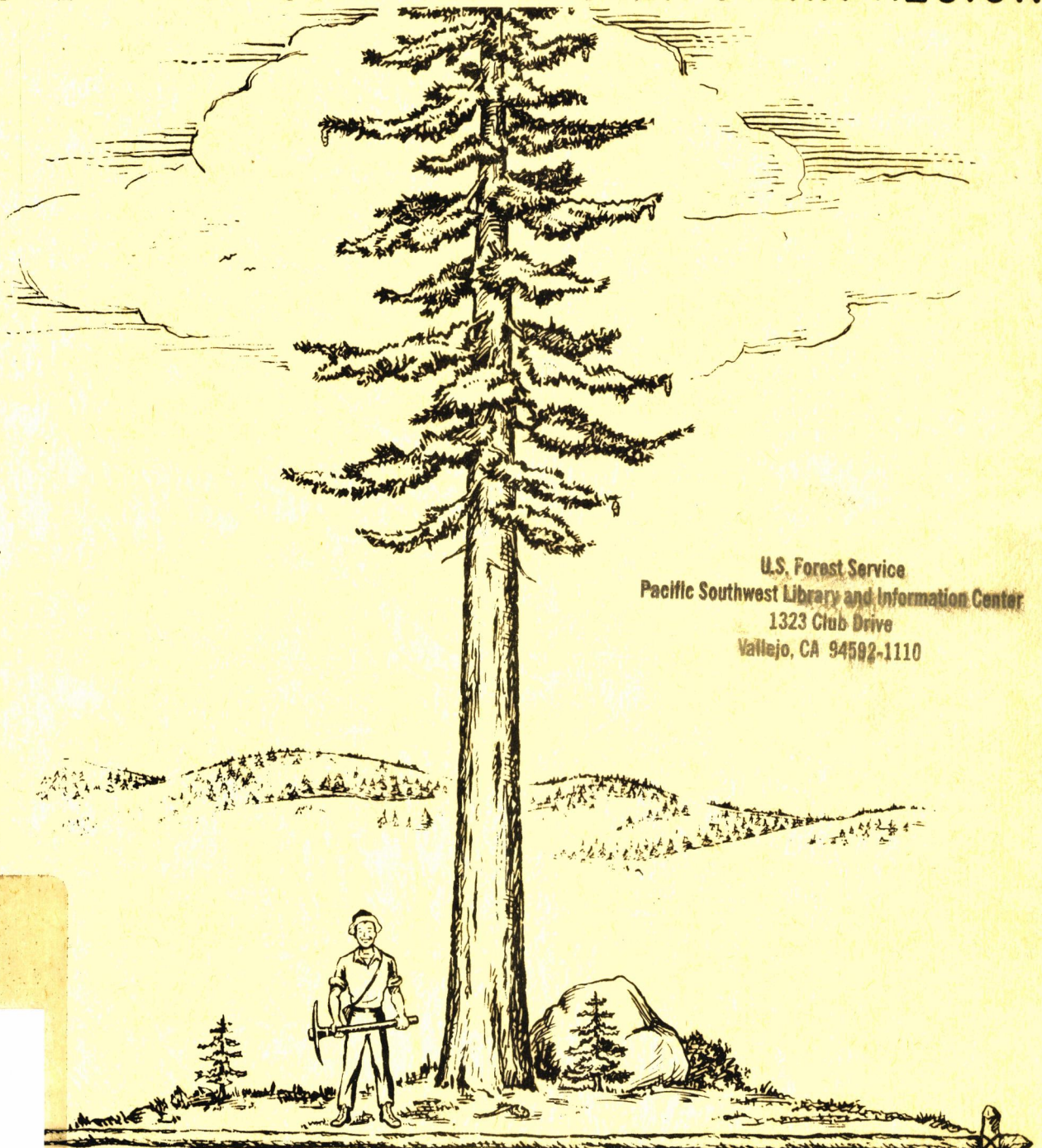
BRC + Sugar Pine

# SUGAR PINE DELINEATION HANDBOOK

FOR

# BLISTER RUST CONTROL IN CALIFORNIA REGION



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# INTRODUCTION

As blister rust control, silvicultural, and management measures are applied to smaller and smaller areas of sugar pine stands and sugar pine growing sites, it becomes increasingly important to know precisely where the stands are, to know their size and shape, and to know as accurately as possible the sugar pine stocking within them. The pattern of sugar pine distribution and the degree of stocking determine where blister rust control and other work may be done. To gather this information, existing control areas must be re-examined, and other sugar pine growing lands scrutinized for possible inclusion in sugar pine management areas.

Studies made over the last few years by the Forest Service, R-5, California Forest and Range Experiment Station, and the University of California have resulted in the adoption of a method of sampling sugar pine areas and evaluating them using economic criteria.

The procedures described in this handbook may be applied to all sugar pine lands in California, regardless of ownership.

The first section will deal with the delineation of immature stands, and the second section with the delineation of mature stands.

# OBJECTIVES

White pine blister rust can be controlled on localized sugar pine stands of limited extent. In order to accomplish this their precise shape and the exact boundaries must be known. In extensive areas where adequate sugar pine values are generally present, small non-sugar-pine areas should be outlined for exclusion.

The application of economic criteria as a measure of a stand's suitability for protection and management requires, among other things, a knowledge of how much sugar pine the stand contains and of how the sugar pine is distributed by diameter classes. The evaluation of stands on economic grounds requires a further delineation of the present control areas based on information gathered by a field survey. Sugar pine stands that meet economic standards have to be outlined for control treatment and management, and conversely submarginal stands must be excluded.

The selection of stands for protection and for intensified sugar pine management is based to a great extent on the data gathered by field parties. Expenditures of substantial amounts of money are made and decisions of importance are reached from analysis of the field data: the accuracy and care with which the data are taken has far reaching effects. Therefore we must accurately find out the following for all classes of ownership.

## IMMATURE STANDS

An immature stand is one in which most of the dominant coniferous trees are less than 150 years of age, that is from seedlings up to and including Dunning's tree classes 1, 2, and 6.

1. The location, extent, and boundaries of individual sugar pine stands down to a minimum of 40 acres that qualify for sugar pine management.

2. The numbers and distribution by size class of all sugar pine crop trees and potential sugar pine crop trees within the stands.

3. The timber types, the rust hazard zones, site class, the brush areas, and pertinent cultural and topographical features.

## MATURE STANDS

A mature stand is one in which the dominant trees are over 150 years of age, that is, are in Dunning's tree classes 3, 4, 5, and 7.

1. The location, extent, and boundaries of individual sugar pine stands down to a minimum of 40 acres that qualify for sugar pine management.

2. The timber types, the rust hazard zones, site class, the brush areas, and pertinent cultural and topographical features.

## NATIONAL FOREST LANDS

To select and rate areas of national forest lands for sugar pine management. A sugar pine management area is one in which the combination of site, sugar pine stocking, cost of protection from blister rust, and the costs of other silvicultural measures are such that the growing of sugar pine is economically feasible.

## STATE AND PRIVATE LANDS

To select and rate areas of private and State-owned lands supporting sufficient sugar pine to warrant the cost of protection from blister rust and to warrant consideration for future silvicultural and management practices.

# DELINEATION OF IMMATURE SUGAR PINE STANDS

The following described procedures are to be followed in selecting and delineating immature (cut-over) stands for intensive management and for protection from white pine blister rust.

All areas of site II or better (height of average dominant at 300 years age--138'+) that appear to have sugar pine type present should be delineated on aerial pictures to a minimum size of 40 acres. This will be done by working circles and blister rust control units on a priority geared to the ribes eradication schedule. After the immature stands have been tentatively selected and delineated on the aerial

photos, additional information on them must be secured by field examination.

## FIELD DATA NEEDED

1. Stocking of sugar pine.

   Sugar pine crop trees by 2" DBH classes to 36" maximum. Record 38" and larger trees for sugar pine volume.

   Potential sugar pine crop trees by 2" DBH classes to 36" maximum.

   All other non-cull sugar pines by 2" DBH classes from 11.0" DBH and up. (These plus the above will give total sugar pine volume.)

2. What will replace the sugar pine crop trees if killed by blister rust; i.e., brush, or which species of tree, or will any replacement occur?

3. The number of trees by species and DBH to be cut to release potential crop trees.

4. The hazard classes present on each area for blister rust infection.

5. An 8"=1 mile map showing timber types, site, rust hazard classes, sugar pine crop tree and potential crop tree stocking, brush areas, cultural and topographical features, and the exact boundaries and marginal ratings of the stands selected for management or blister rust control.

## FIELD EXAMINATION BY THE DELINEATOR

After the immature stands have been delineated on the pictures, a field examination will be made. The delineator should have the pictures with him and every effort will be made to accurately prick section corners and line crossings on them. The delineator will determine the site index, see appendix for procedures.

Some stands will be so sparsely stocked with sugar pine or will have such poor over-all coniferous stocking that they can be rejected by an ocular examination.

A few stands may have so much sugar pine that they can be definitely accepted as management or control areas by ocular examination. The majority of the stands will require a detailed strip survey to determine if they qualify. A detailed 8"=1 mile map must be prepared for all stands except those rejected by ocular examination.

## The Continuous Strip

The detailed survey of these areas will be made by the use of continuous strips. The strips should be run by one man using a hand compass and pacing.

The continuous strip method employs regularly spaced strips, each strip consisting of a series of contiguous sample plots (transects) 1/2-chain wide by 5 chains long. This method yields an estimate of timber stocking through systematic sampling of a stand. With proper spacing of strips the method will give a fairly accurate portrayal of the pattern of sugar pine stocking, including significant variations in stocking.

Supplementary information on timber types, culture, rust hazards, brush, and topography is taken in conjunction with the continuous strip method.

## Width of Strips

Strips are 1/2-chain wide, that is, 16.5 feet on each side of the strip mid-line.

Stocking data are recorded by 5-chain transects. Each transect, which is 1/2-chain wide by 5 chains long, has an area of 1/4 acre. One tree per transect will represent 4 trees per acre.

$$\text{Strip acres} = \frac{\text{Chains of strip}}{20}$$

## Direction of Strips

Run strips either east and west or north and south, whichever direction more nearly crosses the principal streams at right angles.

## Traverse method

Occasionally, it is necessary to sample sugar pine stocking along a stream or in long narrow blocks. This is done by means of a continuous strip run in such a manner as to obtain an adequate and representative sample. The strip is really a succession of short strips, or a traverse, from one edge of the type across to the opposite edge, so that the pattern presented is that of a zigzag line.

The transects are contiguous and are identical in size--that is, 1/2-chain wide by 5 chains long. Direction may change within any transect. Data sheets will be headed "traverse" and strip numbers designated alphabetically. Transects are numbered consecutively and data are entered as in the standard method.

## Procedure for Sampling Narrow Belts of Type (5 chains wide or less) Along a Stream

From the starting point, criss-cross the stream often enough to obtain a representative sample. If repeated crossing of the stream is impracticable, sample each side separately, the strip zigzagging between the bank and the outer edge of the type. When this is done, the two strips will be considered independently and plotted separately on the final map. Data are summarized and plotted on the map by 5-chain transects.

The actual course of the strip is not shown, the 5-chain transects being marked off on the stream. Since the chains of strip do not coincide with the chains of stream, the plotting is diagrammatic. Scale off the length of the stream in chains and divide it by the number of 5-chain transects in the strip. The quotient is the plotted length of the 5-chain transect along the stream on the final map. The segments of streams sampled by the traverse method are enclosed by parentheses. (See sample map.)

## Prodecure for Sampling Belts of Type Greater than 5 Chains Wide

In most cases these areas can be delineated on aerial photos and transferred to a base map with a fair degree of accuracy. A traverse can then be plotted on the work map to assure the necessary acreage sample. This traverse is followed in the field. Each change in direction is noted on the data sheet. The strip is plotted on the final map as it was actually run. (See sample map.) It may be possible to give adequate coverage by running the traverse with short cardinal direction

strips. In order to prevent duplication of data at points where the traverse changes direction, it is necessary to disregard the first 16-1/2 feet of strip on the side adjacent to the previous strip segment. The traverse method will be used only upon instructions by the chief of party.

## Frequency of Strips

Strip numbering ordinarily starts at the northwest corner of the section. The normal interval between strips is 10 chains. Strip #1 would be 5 chains east or south of the northwest corner. Thus as a basic sample, 8 strips per section are run giving a 5 per cent sample. This percentage of sample when supplemented by the delineator's judgment is usually adequate for stands larger than 40 acres.

If intermediate strips are required they are designated by the letter "a" prefixed by the number of the nearest strip to the north or west. Each strip must be numbered both on the map and on the data sheets.

If, upon inspection of the plotted data on the work map, the sample appears inadequate, or if the pattern of sugar pine within the stand is desired in better detail, interpolated strips may be desirable over the entire area or over some part of it. Broad average numbers of sugar pine are much more accurately determined by a given per cent of sample than is the pattern of sugar pine distribution.

If control boundaries are to pass through a 40 or a quarter section, a spacing of strips at 2.5-chain intervals (a total of 32 strips to the mile--a 20 per cent sample) may be necessary on small critical areas. In any case, run as many strips as are needed to show the degree of pattern detail that is wanted and to obtain the desired accuracy of stocking estimate.

In the case of extensive homogeneous stands, 640 acres or larger (where sugar pine distribution is rather uniform) fewer than 8 strips per section may be sufficient. At times it may be possible to run 4 strips (20 chains apart) through this type of stand to establish the overall timber type. Interpolated strips may then be run through the sugar pine types to determine the amount of stocking and the sugar pine pattern.

Where it can be seen that the remainder of a strip will pass through a type in which sugar pine clearly is not present, the strip may be discontinued.

## RECORDING STRIP DATA ON FORM 156-R5 "SUGAR PINE STOCKING DATA SHEET"

Record all sugar pine crop trees up to 36" DBH by the dot and line tally system.

Record all potential sugar pine crop trees up to 36" DBH by the dot and line tally system.

Record these sugar pines by 2" DBH size classes defined as follows:

| | |
|---|---|
| 2 year seedlings to 4.5' high | (the -2" DBH class) |
| 4.6' high to 2.9" DBH | (the 2" DBH class) |
| 3.0" DBH to 4.9" DBH | (the 4" DBH class) |
| 5.0" DBH to 6.9" DBH | (the 6" DBH class) |
| 35.0" DBH to 36.9" DBH | (the 36" DBH class) |

Record all non-cull sugar pines 11.0" and larger in the last column individually by the nearest 2" diameter class including all non-cull sugar pines 38" and above.

Record sugar pines only if one-half or more of the basal area falls within the strip. Strip width should be measured frequently, especially when a tree is on the extreme edge of the strip.

As each crop tree is posted in the appropriate box, record in the box directly beneath what its replacement will be if it is killed by blister rust. If replacement is by a tree, record by species. The diameter of replacements is not recorded. If replacement is by any brush species, record by the letter "B." If nothing will apparently replace the sugar pine crop tree, enter the letter "N."

As each potential crop tree is tallied in the appropriate box, post in the box directly below the tree or trees by species and DBH that will require cutting to release the potential crop tree. Do not record what will replace the potential crop tree if killed by blister rust.

All sugar pine in the above size classes will be recorded, although in evaluating specific stands some of the trees in the larger size classes may not be used, depending on the site, rust hazard class, and the remaining blister rust control costs.

Consecutive blank transects may be summarized on a single line, as "10-20" no data." If there is a special reason for no data, state the reason. Examples: Meadow, fir type, etc.

## STRIP MECHANICS

Dominance and some other crop tree criteria are best determined at a distance where the specific tree can be viewed with respect to its associates in the group. Much time can be saved if the stripman looks ahead to spot his trees. The final decision on crop tree criteria can be made upon closer inspection.

Diameters must be determined as closely as possible. In the appraisal table there is considerable difference in weight among size classes of crop trees. This is especially true in the larger size classes. With practice, most diameters can be readily estimated by eye with frequent measurement checks. For convenience a Biltmore scale may be scratched on a 6-foot steel tape or a 2-foot folding rule. (See table in appendix.)

Paper tags should be hung at the start and end of each strip as well as on roads, trails, streams, and principal ridges crossing the strip. If a strip needs to be rerun these tags are a definite aid in re-establishing the strip. The position of the tag with reference to the ground survey grid should be clearly indicated on the tag. At the end of each strip a tie should be made to the nearest reference point.

The chief of party will frequently accompany the stripman on the strip to insure conformity in the data and to check on accuracy and procedures.

The stripman should habitually mark the center line of his strip at frequent intervals by scratching the duff with his foot. These marks aid in measuring strip width and in assisting the stripman to return to his stopping place after examining trees on the edge of the strip. The center line should be marked so thoroughly that no difficulty will be experienced in retracing any part of the strip.

## DOMINANT SUGAR PINES

Four crown classes are commonly recognized in silviculture: dominant, codominant, intermediate, and suppressed.

A technical definition of dominant (from the Society of American Foresters "Forestry Terminology" 1950, p. 17) is:

"Trees with crowns extending above the general level of the crown cover and receiving full light from above and partly from the side; larger than the average trees in the stand, and with crowns well developed but possibly somewhat crowded on the sides."

By and large the concept of dominance and the crown-class classification relate to even-aged stands and even-aged groups. In mixtures of several age groups and in open stands the concept becomes more difficult to apply. On cut-over lands it cannot always be said that the average dominant has its crown extending above the general level of the crown cover, or that it is larger than the average tree in the stand. The group concept, which considers the relationship between one tree and the others within its sphere of influence, becomes important in such cases. Considering the original definition of dominant in connection with this group concept, it is readily seen that a new, broader definition is required; one which will fit either the even-aged stand dominant or the uneven-aged group dominant.

It can be said that dominant in the general sense implies a position of controlling influence in the forest canopy which a tree may have over others of its same age class.

The dominant or dominants in a group are the ones from which the crop trees will come. This doesn't mean that the crop trees will eventually suppress all the others completely, but that the others won't grow as large as the crop trees, or as fast.

A definitely suppressed tree, regardless of its position, is not a dominant. In smaller openings in older timber and in the immediate vicinity of mature trees small trees often occur that apparently have enough room and overhead light to be classed as dominants for their age class from a positional standpoint. Because of their nearness to the older trees, however, the ground on which these small trees grow may be controlled by the older trees causing a retarding of growth, lack of vigor, and in fact suppression. These are not to be classed as dominants or crop trees.

A dominant tree, depending on age, may be of any size. In theory, it could be 6 inches or 200 feet tall. The following guide may be of help in considering whether or not a tree is dominant. The dominant tree:

1. Is of reasonably normal to better-than-average height for its age. One exception to this is a recently released tree which is showing a marked increase in growth, but is still considerably smaller than average.

2. Has a growth rate at least equal to the average growth rate of other trees of the same age class in its group or in the immediate vicinity--that is, on the same site and growing under similar conditions.

3. Is not masked overhead by any other tree, regardless of age. A line projected upwards through the bole shall not intercept the crown of any other tree. Trees in brush are not dominant unless they distinctly overtop the brush.

4. Is of reasonably normal form. Badly malformed trees should not be classed as dominants. Examples of excessively poor form are a very crooked bole, or such severe damage that the tree is out of the crown class race. Normally growing forked trees may be classed as dominants. Apply the guide of poor form with restraint; if applied loosely it will, in many cases, result in equating dominants with crop trees. Non-crop dominants may have a form of sufficient quality to yield some economic return yet are only tolerated, not desired in the stand.

## SUGAR PINE CROP TREES

The principal characteristic to be used in recognizing sugar pine crop trees is crown-class dominance. Crop trees are selected from sugar pines less than 150 years of age, that is, Dunning's classes 1, 2, and 6 or younger. That is, all dominant sugar pines must be considered for crop tree classification. A crop tree should be a dominant that will remain a dominant until the end of the rotation without artificial help, and will grow to a sufficient size and have the quality to produce good saw timber. In addition to dominance, six further tests are applied. If a dominant pine meets the following six tests, it should be recorded as a crop tree in the appropriate box on form 156-R5, "Sugar Pine Stocking Data Sheet."

## BOLE

The bole of the tree shall be straight, of normal* form and as a general rule unforked. Large trees with a fork high in the top may be considered crop trees if the fork will not significantly reduce the merchantable volume at time of harvest. A relatively moderate crook in the bole may be permitted. More malformation can be allowed in small trees than in large ones. Less malformation is allowable in the first saw log than elsewhere. The bole shall be free of serious fire or porcupine scars. Small scars due to such causes may be permitted, if there is no sign of accompanying decay, and if the tree shows no retardation in growth rate, or diminution in vigor, and has every appearance of good health (no yellowing of needles or thinning of foliage).

## LOGGING DAMAGE

The tree shall be relatively free from damage due to logging operations. Such damage includes broken tops, branches "skinned" off one side, wounds from careless skidding or wire rope scars. Some damage due to such causes may be permitted, however, if the tree shows no retardation in growth rate and no diminution in vigor, and if wounds, when present, are not extensive, show no decay, and are healing rapidly.

## HEALTH

Crop trees shall be reasonably free from mistletoe, fungous diseases, and insects. They shall be vigorous and physiologically healthy. Yellowish or off-color needles are an indication of poor health. Mistletoe often becomes severe on sugar pine, reducing growth and increasing the mortality risk. Small trees with mistletoe or trees under 8" DBH with mistletoe trunk infections should not be classified as crop trees. Trunk infections may be permitted on larger trees if not

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* Definition of normal: The condition one would ordinarily expect to find in good, average dominants growing under at least partial competition on the site and under the general conditions that obtain on the area.

accompanied by any appreciable swelling of the stem. A few branch infections are permissible in larger trees if they are in the lower crown and are small in size, and if there is no evidence of new or recent infections.*

## QUALITY

The general shape of the tree shall be reasonably good. The crown shall be of normal width or narrower. The limbs shall not be excessively large and should be reasonably evenly distributed radially around the bole. The tree shall have reasonably normal to better-than-average vigor. The number of limbs per whorl shall be reasonably normal. For example, a small tree with only two or three branches per whorl is to be considered less than a crop tree whether or not its top is in the sun. Remember that quality refers to the quality of the saw log at the time of harvest.

## GROWTH RATE

The combined length of the last five internodes shall be equal to or greater than the length of those of dominant competitors (of any coniferous species except incense cedar) of the same age class. (Dunning states this test as--"Internode trend equaling or gaining on other dominant competitors of the age class.") In dense groups a check on diameter growth as well as on height growth will help in selecting the crop trees. Other things being equal, the tree with the greatest diameter growth has the best chance of surviving. A competitor is any dominant conifer that threatens to reduce the dominant sugar pine to a lower crown class or to crowd it from the stand. The competition offered by incense cedar may be discounted somewhat from that offered by other coniferous associates of sugar pine. Trees to the south of a sugar pine are more serious in competition than similar trees to the north.

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* The species of mistletoe attacking sugar pine is Arcenthobium campylopodum form blumeri. A good account of this parasite may be found beginning on p. 349 of J.S. Boyce's "Forest Pathology," edition of 1938.

## SPACING

On logged lands where young age classes (small trees) are abundant, it will sometimes happen that many more dominants will meet the crop tree tests than there is space to accommodate them at the end of the rotation. In such cases select the most vigorous dominants as crop trees with due regard to adequate spacing, allowing reasonable space for each crop tree to grow to full size without too much crowding. Reasonable space will be demonstrated in the field rather than defined here. Of two dominant sugar pines growing side by side ("twins," within 4 or 5 feet of each other) equal in height, growth rate and vigor, both of which meet all the crop tree tests, one only may be called a crop tree. The reason for eliminating the other is inadequate spacing.

In the large size classes where more positive appraisal can be made, an occasional exception to the "twin" rule may be found. In such cases both trees should be recorded as crop trees. As a general rule, the number of crop trees and potential crop trees per 1/2 chain of strip is a good guide as to whether too many trees are being considered for the final crop. For example, recognizing that crop trees may be of any species, if three crop trees per 1/2 chain of strip are picked out, this is 30 crop trees per 1/4-acre plot. (3 crop trees x 10 one-half-chain segments = 30 crop trees.) Further expanded, this is 120 crop trees per acre or full stocking. However, it is possible that there may be more than 3 crop trees per 1/2 chain of strip, depending upon the arrangement within and stocking adjacent to the 1/2-chain sample.

## POTENTIAL CROP TREES

Sugar pines that meet all criteria for a crop tree except dominance and that might be brought to rotation age by release cutting of associated species (including black oak or other hardwoods) shall be recorded. These sugar pines are generally codominants or thrifty intermediates, never trees showing signs of suppression.

Do not consider cutting a ponderosa pine crop tree to release a sugar pine.

Dominant sugar pines that fail to classify as crop trees because of growth rate (that is when a competing tree may overtop the sugar pine) should be recorded as potential crop trees if they can be released

through cutting of the competing trees of any species except ponderosa pine. A ponderosa pine may be cut if it is of poor form or otherwise does not meet the crop tree requirements.

Vigorous, thrifty sugar pines dominant in their age class but growing under the crown of a mature tree are not allowed as dominants. If in all other respects these overtopped trees meet the requirements for crop trees, they should be recorded as potential crop trees. The assumption is that the mature trees will be cut in the next cutting cycle, which on most lands will probably be within the next 10 to 20 years, thus releasing the younger trees completely.

Some judgment should of course be exercised, if the leader of the sugar pine will shortly become entangled in the lower limbs of the over-shadowing crown (including those instances where sugar pine occurs beneath black oak) and stands a chance of becoming disabled, the pine should not be classified as a potential crop tree.

Dominant trees being eliminated by those dominant competitors of the same age class plus codominant trees that may be released through logging or silvicultural methods are the best source of potential crop trees.

Care should be exercised to ensure that codominant trees are not overlooked and that they are given full consideration.

## MAPPING AND RECORDING OF SUPPLEMENTARY DATA

Prepare a work map of the area on a scale of 8"=1 mile in accordance with the map symbols and instructions given below. The map should show the principal cultural and topographical features. These data should be secured from the best available sources, such as blister rust checking maps, aerial pictures, administrative maps, cruise maps or U.S. Geological Survey quadrangles.

Where feasible, timber types and blister rust hazard classes should be delineated on the aerial photographs and transferred to the work map. Areas of mature stands, immature stands, lightly cut stands, and large poles should be mapped separately. When known, the site index should be shown.

Type lines, cultural and other features should be corrected as the field examination is being made.

## MAP SYMBOLS - SUGAR PINE DELINEATION

Type boundary ----------

Cut-over boundary----------

Rust hazard class boundary (in red) ----------

High-hazard class along stream (red "X")--------

No. of crop trees per 5-chain transect ---------

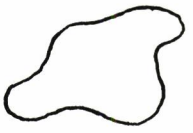
No. of potential crop trees per 5-ch. trans.

Evaluated stand boundary (in green) ----------

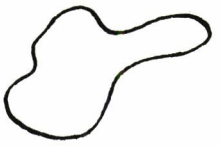
Site-cost level-marginal score (in red) ----------

I - IMD-230

Area selected as suitable for sugar pine management (solid green line and area colored green) ----------



Areas with no possibilities for management. Brush, low site, pure fir or PP---------- (solid brown line and colored brown)



Ownership (yellow line) ----------



National forest lands (in yellow letters) ---------

U.S.

Private lands (in yellow letters) ----------

P.

## TIMBER TYPE SYMBOLS *

| Symbol | Common Name | Scientific Name |
|---|---|---|
| $\hat{W}$ | White fir | Abies concolor |
| $\hat{R}$ | Red fir | Abies magnifica |
| $\hat{S}$ | Shasta fir | Abies magnifica shastensis |
| I | Incense cedar | Librocedrus decurrens |
| L | Lodgepole pine | Pinus contorta |
| W | Western white pine | Pinus monticola |
| S | Sugar pine | Pinus lambertiana |
| S- | Sugar pine present but in amount less than 20 per cent | |
| Y | Ponderosa (yellow pine) | Pinus ponderosa |
| J | Jeffrey pine | Pinus jeffreyi |
| K | Knobcone pine | Pinus tuberculata |
| D | Douglas fir | Pseudotsuga taxifolia |
| Bt | Big-tree | Sequoia gigantea |
| Q | Oak--any species (tree form) | Quercus spp. |
| T | Tan oak (tree form) | Lithocarpus densiflora |

## BRUSH TYPE SYMBOLS **

| | | |
|---|---|---|
| A | Manzanita--any species | Arctostaphylos spp. |
| C | Ceanothus--any species except Ceanothus cordulatus, whitethorn | Ceanothus spp. |
| Ccs | Whitethorn | Ceanothus cordulatus |
| Cs | Chinquapin | Castanopsis sempervirens |
| Q | Oak--any brush species | Quercus spp. |
| L | Tan oak (brush form) | Lithocarpus densiflora |
| Bc | Bear clover | Chamaebatia foliolosa |
| Cn | Dogwood | Cornus spp. |
| Cr | Hazel nut | Corylus rostrata californica |
| P | Choke or Bitter Cherry | Prunus spp. |

*For additional timber-type symbols and related information see the pictorial atlas folio titled "The Timber Stand and Vegetation-Soil Maps of California," January 15, 1949.

**Where a genus or species of brush not listed above is common and important enough to be shown, use the symbol for it given in Wieslander's "List of Symbols," April 19, 1935.

Examples of timber type with brush understory:

| Y-Pure | SY | $\hat{SW}$ | Y |
|---|---|---|---|
| A, Cco, -8 | C, Cs, L, -7 | A, Q-5 | Bc-9 |

## LAND STATUS SYMBOLS

| | |
|---|---|
| Br<br>A, Cs-8 | Brush. Show beneath the brush symbol the principal brush genera (or species) and their total density. In the example manzanita and Sierra chinquapin, occupy 8/10 of the ground space. |
| Burn '47<br>90% | (Burn-Year/ % kill) Burn, probably recent and not classed as some combination of brush and timber type. |
| Ba -------- | Barren. |
| Cu -------- | Cultivated. |
| Mdw ------- | Meadow. |
| N --------- | Noncommercial timber sites such as:<br>1. Granite outcrops with stunted ponderosa pine.<br>2. Poor rocky soil with some trees or brush.<br>3. Rock outcrops with oaks.<br>Write principal description of ground condition as "rock and trees," "granite slope," etc., after the symbol N. |

## MAPPING RUST HAZARD CLASSES

Recent studies and analysis of white pine blister rust infections indicate that whereas in Oregon and northern California the disease is developing in its normally destructive pattern, it is being retarded by the long, hot, dry summer climate that is typical of the Sierra Nevada sugar pine belt of California. While there is no definite line of demarkation between these two zones of rust behavior as they grade slowly one into the other, Mt. Lassen in northern California roughly separates the region geographically between most of the Cascade Range and the Siskiyou Range to the north, and the Sierra Nevada to the south.

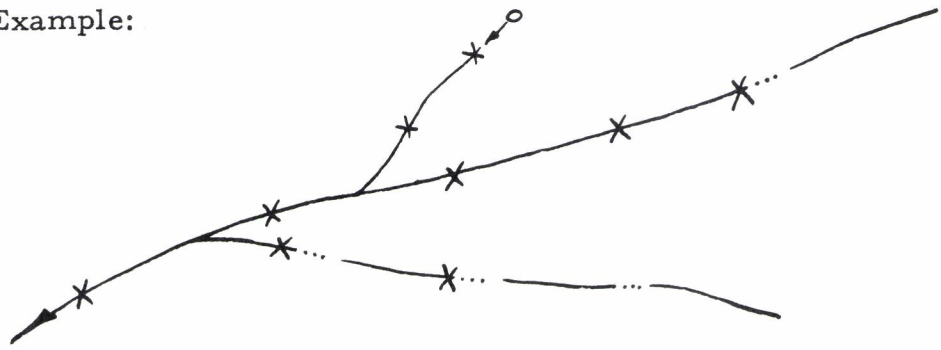
Mt. Lassen, therefore, will be used to separate the region into two zones for the purpose of definition. Within each of these two broad geographic zones, may be found variations in rust hazard from one slope to another within the same drainage basin, a variation that does not result solely from differences in ribes populations. The influence of

host susceptibility to rust as well as factors of moisture and temperature between slopes also is apparent.

These different hazard classes, although seldom clear-cut and distinct as to boundary limits, can be identified and separated by field observations.

Using the following descriptions and indicators, outline the areas of high and low hazard in red on the field map. Insert the word "LOW" or "HIGH" (printed in red) within the area enclosed. Where high hazard follows a narrow strip along each side of a stream or draw, mark a red "X" at frequent intervals to indicate high hazard.

Example:



The following rust hazard classes have been set up:

## BLISTER RUST HAZARD CLASSIFICATION

As a result of variation in the incidence and rate of development of blister rust differing degrees of rust hazard are present in the sugar pine type. Therefore, to give adequate protection to sugar pine it is not necessary to reduce the ribes live stem to the same level on all areas. Where local climate is favorable for rust development, ribes live stem must be reduced to and maintained at a low level. On drier and less favorable rust sites more ribes live stem can be tolerated. Accordingly three rust-hazard classes have been established. To protect the pine on a specific area ribes live stem must not exceed certain limits. These limits are different for the three hazard classes. These classes are:

### High Hazard

These are areas where local climatic and moisture conditions are

favorable for the introduction and intensification of blister rust. Most initial infection within a locality will become established on sugar pine growing under these favorable conditions. High hazard is usually associated with water and with moist, cool situations. Zones adjacent to streams, meadows. lakes, or other cool, moist places are potentially dangerous rust areas. The high hazard coincides with the direct influence of the water. Moist flats are particularly hazardous. Most of the sugar pine type north of Mt. Lassen and north of the Yolla Bolla Mountains in the Coast Ranges is in the high-hazard class. Nearly all areas throughout the sugar pine type adjacent to streams are high hazard.

### Medium Hazard

These are areas where conditions are only moderately favorable for rust development and local spread. Rust usually becomes established in the intermingled high-hazard areas and then spreads into the medium-hazard areas. Middle and high elevation south slopes, most north slopes, and mixed coniferous timber type not immediately adjacent to streams are usually classed as medium hazard. Most of the sugar pine type south of Mt. Lassen and on the Mendocino Forest is in the medium-hazard class.

### Low Hazard

These are areas where conditions of local climate are generally unfavorable for blister rust incidence and spread. The hot dry sugar pine-ponderosa pine type at the medium to low elevations is often low hazard. If many ribes or more than an occasional fir or dogwood are present in the stand, it is not classed as low hazard. There are relatively few low-hazard areas north of Highway 50.

## PLANT INDICATORS OF HIGH-HAZARD AREAS

Aspen (*Populus tremuloides*)
Red Fir (*Abies magnifica*)
Dwarf maple (*Acer Glabrum*)
Pine-mat manzanita (*Arctostaphylos nevadensis*)
Sticky currant (*Ribes viscosissimum*)
Mountain ash (*Sorbus sitchensis*)
Mountain alder (*Alnus tenuifolia*)
Bitter cherry (*Prunus emarginata*)
Azalea (*Rhododendron occidentale*)

## PLANT INDICATORS OF MEDIUM-HAZARD AREAS

White fir (Abies concolor)
Douglas fir (Pseudotsuga taxifolia)
Flowering dogwood (Cornus nuttallii)
Chinquapin (Castanopsis sempervierens)
Service berry (Amelanchier alnifolia)
Thimble berry (Rubus parviflorus)
Ground rose (Rosa spithamea)
Ground waxberry (Symphoricarpos)
Sierra currant (Ribes nevadense)
Hazel brush (Corylus californica)
White alder (Alnus rhombifolia)

## PLANT INDICATORS OF LOW-HAZARD AREAS

Jeffrey pine, below usual altitude for the area.
Preponderance of ponderosa pine.
Dense vigorous stands of bear clover.
Cream bush or ocean spray (Holodiscus discolor)
Bear brush (Garraya fremontii)
Rabbit brush (Chrysothamnus spp.)
Huckleberry oak (Quercus vaccinifilia)
Mountain mahogany (Cercocarpus betuloides)
Canyon live oak (Quercus chrysolepis)
Sticky manzanita (Arctostaphylos vicida, A. mariposa)
Mustang mint (Monardella lanceolata)
Poison oak (Rhus diversiloba)

## NEGATIVE INDICATORS

If these are present the area is not a low-hazard area.

Dwarf maple (Acer glabrum)
Aspen (Populus tremuloides)
Mountain ash (Sorbus sitchensis)
Most willows (Salix spp.)
Alders (Alnus spp.)
Hazel brush (Corylus rostrata)
Clovers (Trilolium spp.)
Rushes (Scirpus spp.)
Sedges (Carex spp.)
Azalea (Rhododendron occidentale)

Sierra currant (Ribes nevadense)
Swale lupine (Lupinus latifolius)
Big leaf maple (Acer macrophyllum)
Creek dogwood (Cornus californica, C. sessilis)
Red fir (Abies magnifica)
Lodgepole pine (Pinus contorta)
Flowering dogwood (Cornus nuttallii)
Douglas fir (Pseudotsuga taxifolia)
Chinquapin (Castanopsis sempervierens)
Pine-mat manzanita (Arctostaphylos nevadensis)
Bitter cherrry (Prunus emarginata)
Sticky currant (Ribes viscosissimum)

## MAPPING OF TIMBER TYPES

Map the timber types as accurately as possible and to as small an area as will have bearing in the planning of control work. A 2-to-10-acre brush patch, lava ridge, or open granite slope may influence the placing of the control boundary. On the other hand the differences between $S\hat{W}$ and SD may not be significant on areas of less than 40 acres, and in such cases type distinctions do not have to be as accurately mapped. The presence or absence of sugar pine is, of course, the most important distinction.

The various timber types are to be designated by combinations of the symbols for the coniferous species. To enter into the type designation a species should form 20 per cent or more of the coniferous cover. This definition may be roughly amplified to mean 20 per cent or more of the number of trees. The order of the symbols in type designation should indicate the relative abundance of the species, except that the symbol for sugar pine (S) should always be placed first. Do not enter any species composing less than 20 per cent of the coniferous cover except sugar pine when sugar pine is less than 20 per cent but generally present indicate by S-.

## MAPPING OF BRUSH TYPES

1. In any timber type where brush as an understory occupies one-half or more of the ground space (density .5+), show the kinds of brush and their total density placed below the type designation, as in these examples:

| Y-Pure | SY | $\hat{SW}$ | Y |
|---|---|---|---|
| A, Cco-8 | C, Cs, L, -7 | A, Q, -5 | Bc-9 |

The first example describes a pure ponderosa pine type with a ground cover of manzanita and whitethorn that occupies 8/10 of the ground space. The purpose of showing the amount of brush is to indicate those areas where brush either has or is gaining control of the ground. Type lines need not be drawn to separate brush densities within the same timber type.

2. Since most of the stocking surveys will be conducted on cut-over land, no cut-over type designation will be used. Odd blocks of uncut timber falling within the survey shall be clearly marked "VIRGIN," and shown with the timber cut-over boundary line.

3. If there is little sugar pine reproduction on the land being surveyed, but a good reserve stand of sugar pine, note this on the map. See instructions for mature stands.

## PREPARATION OF THE FINAL MAP

An 8"=1 mile map is to be made for each stand surveyed. The final map should be prepared as soon as possible after the field work is completed. The following information is to be shown on the final map:

1. The timber types.
2. Brush type where required.
3. The survey strips with the crop and the potential crop trees plotted by 5-chain transects.
4. The blister rust hazard classes.
5. The pertinent cultural and topographical features.
6. The land ownership.
7. The exact boundaries of each stand evaluated.
8. The site and blister rust control cost and the marginal score of each stand evaluated.
9. The location and extent of all areas of brush, low site, and fir or ponderosa types that have no possibility for sugar pine management.

10. The exact boundaries of each stand selected for sugar pine management or for blister rust control.

The timber and brush types, the cultural and topographical features and the strip data are to be plotted on a base vellum or tracing cloth.

Plot each strip on the vellum or tracing cloth and mark off the 5-chain transects. For each 5-chain transect place the number of sugar pine crop trees 0-36" DBH above the plotted line and the number of potential sugar pine crop trees 0-36" below the plotted line. The stand boundaries, site, cost level, marginal scores and ownership are to be added to a final print.

## STRIP ADJUSTMENT

The paced distance between two points rarely coincides with the known or assumed distance. The error is usually cumulative and it may be assumed that the distribution of error is uniform from the beginning to the end of the strip. Since trees are tallied by 5-chain transects it is difficult to proportion errors over the entire strip. When plotting strips on the final map apply the following rules for strip adjustment:

1. If paced distance is 0 to 2-1/2 chains over or under the known distance, include the trees tallied in these "odd" chains in the last 5-chain transect. (e.g. Plot the strip as if paced the true distance.)

2. If the error is greater than 2-1/2 chains (over or under true distance) add or subtract an extra 5-chain transect. When plotting on the final map reduce or enlarge each 5-chain transect so that all 5-chain transects tallied will be included within the true distance.

3. Examples: There are sixteen 5-chain transects in 80 chains of strips. Should the strip be paced from 82-1/2 to 87-1/2 chains, 17 transects would be plotted to the equivalent of 80 chains. Should the strip be paced from 72-1/2 to 77-1/2 chains, 15 transects would be plotted to the equivalent of 80 chains. There should seldom be an error in pacing over 5 chains.

IMPORTANT Be sure to jibe all maps. All features placed on the vellums or tracings must be matched with the corresponding features on maps of adjoining areas. A map is not complete until this has been done.

Make at least two prints of each map.

# EVALUATION OF SUGAR PINE STANDS

Sugar pine stands to be evaluated must be selected with care and should be as homogeneous as possible. Stands should be evaluated and final maps made as soon as the data are available. All information available should be analyzed carefully--aerial photographs, sugar pine occurrence (as shown by the strip data), timber types, rust hazards, topography, and timber densities. All other pertinent conditions should be considered in determining the extent of the specific stand to be appraised.

In most cases the regular land survey section will be too large and will contain stands too diverse for evaluating as a unit. All non-sugar-pine type should be first eliminated from consideration. The sugar pine stands should then be separated into homogeneous blocks. Often a stand will extend over parts of several G. L. O. sections; in this case it should be evaluated in its entirety. The G. L. O. section should not be the basic unit, but used merely as a mapping and reference unit. The individual homogeneous sugar pine stand rather small in extent must be used as the basic unit.

Rating tables by site are to be used in evaluating stands.

When using the management tables, the aggregate percentage assigned to the larger trees must not exceed certain limits as prescribed in the footnotes in the tables. Also the maximum tree size used varies but this is inherent with the use of the table and no adjustment need be made.

The following procedure is to be used in evaluating specific sugar pine stands:

1. Draw a line (preferably with a colored pencil) across form 156-R5, "Sugar Pine Stocking Data Sheet," at the point (5-chain transect) of entry and departure from any one hazard class using the letter "H," "M," or "L" within the lines to indicate the hazard class delimited. To do this refer to the sugar pine delineation map and take those transects within any one hazard and outline them on form 156-R5, "Sugar Pine Stocking Data Sheet," as indicated above. If a transect falls in two hazards, place the entire transect in that hazard within which most of it falls.

2. Transfer the data from form 156-R5, by hazard class to form 155-R5, "Sugar Pine Stand Evaluation Sheet," for the strips and parts of strips falling within the stand being evaluated. A separate form 155-R5, should be used for each hazard class within the stand.

3. On 155-R5 total the crop trees and potential crop trees by size classes.

4. Enter the site where indicated in the heading.

5. Enter in the heading the "remaining control cost in man days." This will be determined by the Blister Rust Control officer.

6. Select from the table the proper value of one tree for each size class expressed in per cent of the marginal stand. Enter on 155-R5 the value of one tree for each size class, as determined by site, hazard, and cost of control, in their proper places in the next to last line which is captioned "One crop tree as per cent of marginal stand."

7. Multiply the percentage value of one crop tree by the total number of crop trees for each size class. Enter the results on the bottom line of form 155-R5.

8. With regard to remaining control cost and hazard in the footnotes on the tables pick the limit within which the crop trees and potential crop trees must be evaluated. This limit should be marked on 155-R5 with a line (preferably with colored pencil) drawn between the size classes that need special consideration.

9. Total the percentages in the line captioned "Total per cent of size class" within the limits of the lines drawn in step No. 8. These totals should then be entered in the "Hazard Evaluation" table on form 155-R5. Then enter the total strip acres as found on form 156-R5 and divide into column 1 (percentage). An addition of these two divisions (quotients) results in the "per cent of the marginal stand" for this hazard. Care at this point must be exercised so as the percentage of the larger trees does not exceed the limits designated in the footnotes of the tables. Therefore, a blank has been provided at the right of the "Hazard Evaluation" table where the maximum per cent in larger trees allowed (to be derived from the footnotes) may be entered to aid the evaluator and to provide a check for any subsequent analysis. For example, where the remaining

cost is 1.1-2.0 man days and the hazard is medium, the aggregate percentage after dividing by the strip acres (on larger trees) must not exceed the percentages shown in the tables.

10. The box headed "Total Stand Evaluation" is to be used (on only one of the three hazard sheets in a specific stand) to total the results of the hazard classes. This is done by entering the "per cent of marginal stand by hazard" values (column 1) and the total strip acres for each hazard (column 2). By multiplying the percentage by the strip acres (column 1 x column 2) (thereby weighing each hazard), totaling, and dividing by the total strip acres (total column 3 divided by total column 2) the "per cent of the marginal stand" is the result. This is the value of the stand expressed in percentage of the economic break-even point as determined by Henry J. Vaux.*

11. Under "Remarks" on 155-R5 briefly state any information that doesn't show up in the appraisal sheet or final map. Such information as: Good sugar pine reproduction, good residual stand, many trees discounted because of mistletoe, or other remarks pertinent to the sugar pine that may be of help to the Blister Rust Control officer in setting control boundaries.

Appraisal blocks should be outlined on the final map prints and the appraisal percentage entered in each block.

Control unit boundaries will be set by the Blister Rust Control officer, after an analysis of the many factors involved. The major factors to be considered are:

1. The economic value as expressed on 155-R5 for each stand selected. The economic evaluation of a stand should obviously receive the most weight. Several of the other factors will already have been evaluated in the process of reaching the economic value, but in certain cases a second look at some factors and a weighing of their relative importance may help to reach a decision.

2. The relationship of individual stands to one another.

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*California Agricultural Experiment Station, Bulletin No. 738, "Economics of the Young-Growth Sugar Pine Resource."

3. The rust-hazard classes. The rust-hazard classes may be, in actual acreage, small within any one stand. And there are those instances where a particular hazard may not be important as a separate unit within the stand. In such cases the hazard may be disregarded, but this is an administrative decision based on the size of the area, general location of the type, and past experience with the specific area.

4. The timber types.

5. The topography.

6. The size classes of the sugar pine.

7. The size of the residual stand.

8. The cost of control.

9. The over-all management plan for the area.

10. The ground cover.

11. Values other than sugar pine timber production.

## Table A-1. Per cent of Marginal Stand Contributed by One Sugar Pine Crop Tree, by Present Tree d.b.h., Level of Control Cost, and Intensity of Rust Hazard (Site A-200—managed stand)

| Present tree d.b.h. | Level of control cost | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0–1.0 m.d./acre | | | 1.1–2.0 m.d./acre | | | 2.1–3.0 m.d./acre | | | 3.1–4.0 m.d./acre | | | 4.1–6.0 m.d./acre | | |
| | High | Med. | Low | High | Med. | Low | High | Med. | Low | High | Med. | Low | High | Med. | Low |
| (inches) | | | | | | | | | | | | | | | |
| −2 | 25.6 | 22.5 | 17.7 | 15.6 | 13.7 | 10.8 | 11.0 | 9.7 | 7.6 | 8.2 | 7.3 | 5.7 | 6.0 | 5.2 | 4.1 |
| 2 | 30.4 | 25.5 | 19.0 | 18.5 | 15.5 | 11.6 | 13.1 | 11.0 | 8.2 | 9.8 | 8.2 | 6.1 | 7.1 | 5.9 | 4.4 |
| 4 | 37.0 | 29.6 | 21.2 | 22.5 | 18.0 | 12.9 | 15.9 | 12.7 | 9.1 | 11.9 | 9.5 | 6.8 | 8.6 | 6.9 | 4.9 |
| 6 | 45.0 | 34.2 | 23.2 | 27.4 | 20.8 | 14.1 | 19.3 | 14.7 | 9.9 | 14.5 | 11.0 | 7.4 | 10.5 | 8.0 | 5.4 |
| 8 | 53.4 | 38.1 | 23.9 | 32.5 | 23.2 | 14.6 | 22.9 | 16.4 | 10.3 | 17.2 | 12.3 | 7.7 | 12.4 | 8.9 | 5.6 |
| 10 | 63.8 | 41.9 | 26.6 | 38.8 | 25.5 | 16.2 | 27.4 | 18.0 | 11.4 | 20.5 | 13.5 | 8.5 | 14.8 | 9.7 | 6.2 |
| 12 | 74.7 | 48.1 | 31.8 | 45.5 | 29.3 | 19.4 | 32.0 | 20.6 | 13.6 | 24.0 | 15.4 | 10.2 | 17.4 | 11.2 | 7.4 |
| 14 | 81.4 | 52.5 | 35.4 | 49.6 | 31.9 | 21.5 | 34.9 | 22.5 | 15.2 | 26.2 | 16.9 | 11.4 | 18.9 | 12.2 | 8.2 |
| 16 | 87.0 | 55.5 | 42.2 | 53.0 | 33.8 | 25.7 | 37.3 | 23.8 | 18.1 | 28.0 | 17.8 | 13.6 | 20.2 | 12.9 | 9.8 |
| 18 | 49.6 | 30.7 | 25.9 | 30.2 | 18.7 | 15.8 | 21.3 | 13.2 | 11.1 | 15.9 | 9.9 | 8.3 | 11.5 | 7.1 | 6.0 |
| 20 | 45.3 | 31.7 | 28.3 | 27.6 | 19.3 | 17.3 | 19.4 | 13.6 | 12.2 | 14.6 | 10.2 | 9.1 | 10.5 | 7.4 | 6.6 |
| 22 | 47.3 | 35.1 | 32.2 | 28.8 | 21.4 | 19.6 | 20.3 | 15.1 | 13.8 | 15.2 | 11.3 | 10.4 | 11.0 | 8.2 | 7.5 |
| 24 | 48.7 | 38.6 | 36.5 | 29.7 | 23.5 | 22.2 | 20.9 | 16.6 | 15.7 | 15.7 | 12.4 | 11.7 | 11.3 | 9.0 | 8.5 |
| 26 | 48.1 | 41.6 | 39.9 | 29.3 | 25.4 | 24.3 | 20.6 | 17.9 | 17.1 | 15.5 | 13.4 | 12.8 | 11.2 | 9.7 | 9.3 |
| 28 | 45.9 | 43.4 | 42.8 | 28.0 | 26.4 | 26.1 | 19.7 | 18.6 | 18.4 | 14.8 | 14.0 | 13.8 | 10.7 | 10.1 | 10.0 |
| 30 | 48.5 | 46.5 | 45.8 | 29.5 | 28.3 | 27.9 | 20.8 | 19.9 | 19.7 | 15.6 | 14.9 | 14.7 | 11.3 | 10.8 | 10.7 |
| 32 | 51.1 | 51.1 | 51.1 | 31.1 | 31.1 | 31.1 | 21.9 | 21.9 | 21.9 | 16.4 | 16.4 | 16.4 | 11.9 | 11.9 | 11.9 |
| 34 | 40.9 | 40.9 | 40.9 | 24.9 | 24.9 | 24.9 | 17.6 | 17.6 | 17.6 | 13.2 | 13.2 | 13.2 | 9.5 | 9.5 | 9.5 |
| 36 | 24.9 | 24.9 | 24.9 | 15.2 | 15.2 | 15.2 | 10.7 | 10.7 | 10.7 | 8.0 | 8.0 | 8.0 | 5.8 | 5.8 | 5.8 |

Note: In calculating the marginal rating of any stand, the aggregate percentage assigned to the larger trees must not exceed certain limits. These limits are as follows:

0–1.0 man days control cost: Not more than 40% in trees
1.1–2.0 man days control cost: Not more than 25% in trees
2.1–3.0 man days control cost: Not more than 17% in trees
3.1–4.0 man days control cost: Not more than 13% in trees
4.1–6.0 man days control cost: Not more than 9% in trees

} 14″ or larger on "Low" hazard.
24″ or larger on "Medium" hazard.
28″ or larger on "High" hazard.

## Table A-2. Per cent of Marginal Stand Contributed by One Sugar Pine Crop Tree, by Present Tree d.b.h., Level of Control Cost, and Intensity of Rust Hazard (Site I-175—managed stand)

| Present tree d.b.h. | Level of control cost | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0–1.0 m.d./acre | | | 1.1–2.0 m.d./acre | | | 2.1–3.0 m.d./acre | | | 3.1–4.0 m.d./acre | | | 4.1–6.0 m.d./acre | | |
| | High | Med. | Low | High | Med. | Low | High | Med. | Low | High | Med. | Low | High | Med. | Low |
| (inches) | | | | | | | | | | | | | | | |
| −2 | 11.7 | 10.3 | 8.1 | 7.1 | 6.3 | 4.9 | 5.0 | 4.4 | 3.5 | 3.8 | 3.3 | 2.6 | 2.7 | 2.4 | 1.9 |
| 2 | 14.9 | 12.5 | 9.4 | 9.1 | 7.6 | 5.7 | 6.4 | 5.4 | 4.0 | 4.8 | 4.0 | 3.0 | 3.5 | 2.9 | 2.3 |
| 4 | 18.7 | 14.8 | 10.5 | 11.4 | 9.0 | 6.4 | 8.0 | 6.4 | 4.5 | 6.0 | 4.8 | 3.4 | 4.4 | 3.4 | 2.4 |
| 6 | 24.4 | 18.7 | 12.8 | 14.9 | 11.4 | 7.8 | 10.5 | 8.0 | 5.5 | 7.9 | 6.0 | 4.1 | 5.7 | 4.3 | 3.0 |
| 8 | 28.7 | 20.6 | 13.1 | 17.4 | 12.6 | 8.0 | 12.3 | 8.9 | 5.6 | 9.2 | 6.6 | 4.2 | 6.7 | 4.8 | 3.1 |
| 10 | 38.0 | 25.3 | 16.6 | 23.1 | 15.4 | 10.8 | 16.3 | 10.9 | 7.1 | 12.2 | 8.1 | 5.3 | 8.8 | 5.9 | 3.8 |
| 12 | 45.6 | 30.3 | 20.9 | 27.8 | 18.4 | 12.7 | 19.6 | 13.0 | 9.0 | 14.7 | 9.7 | 6.7 | 10.6 | 7.0 | 4.9 |
| 14 | 51.5 | 34.4 | 24.3 | 31.4 | 21.0 | 14.8 | 22.1 | 14.8 | 10.4 | 16.6 | 11.1 | 7.8 | 12.0 | 8.0 | 5.6 |
| 16 | 57.8 | 38.5 | 30.4 | 35.2 | 23.4 | 18.5 | 24.8 | 16.5 | 13.1 | 18.6 | 12.4 | 9.8 | 13.4 | 9.0 | 7.1 |
| 18 | 31.5 | 20.2 | 17.4 | 19.2 | 12.3 | 10.6 | 13.5 | 8.7 | 7.5 | 10.1 | 6.5 | 5.6 | 7.3 | 4.7 | 4.0 |
| 20 | 32.6 | 24.0 | 21.9 | 19.8 | 14.6 | 13.3 | 14.0 | 10.3 | 9.4 | 10.5 | 7.7 | 7.0 | 7.6 | 5.6 | 5.1 |
| 22 | 34.4 | 26.7 | 24.9 | 20.9 | 16.2 | 15.2 | 14.7 | 11.4 | 10.7 | 11.0 | 8.6 | 8.0 | 8.0 | 6.2 | 5.8 |
| 24 | 35.4 | 29.1 | 27.8 | 21.5 | 17.7 | 16.9 | 15.2 | 12.5 | 11.9 | 11.4 | 9.4 | 8.9 | 8.2 | 6.8 | 6.5 |
| 26 | 35.8 | 31.7 | 30.7 | 21.8 | 19.3 | 18.7 | 15.4 | 13.6 | 13.2 | 11.5 | 10.2 | 9.9 | 8.3 | 7.4 | 7.1 |
| 28 | 33.6 | 33.6 | 33.6 | 20.4 | 20.4 | 20.4 | 14.4 | 14.4 | 14.4 | 10.8 | 10.8 | 10.8 | 7.8 | 7.8 | 7.8 |
| 30 | 27.9 | 27.9 | 27.9 | 17.0 | 17.0 | 17.0 | 12.0 | 12.0 | 12.0 | 9.0 | 9.0 | 9.0 | 6.5 | 6.5 | 6.5 |
| 32 | 15.0 | 15.0 | 15.0 | 9.2 | 9.2 | 9.2 | 6.5 | 6.5 | 6.5 | 4.8 | 4.8 | 4.8 | 3.5 | 3.5 | 3.5 |

Note: In calculating the marginal rating of any stand, the aggregate percentage assigned to the larger trees must not exceed certain limits. These limits are as follows:

0–1.0 man days control cost: Not more than 40% in trees
1.1–2.0 man days control cost: Not more than 25% in trees } 14″ or larger on "Low" hazard.
2.1–3.0 man days control cost: Not more than 17% in trees } 24″ or larger on "Medium" hazard.
3.1–4.0 man days control cost: Not more than 13% in trees
4.1–6.0 man days control cost: Not more than 9% in trees } 28″ or larger on "High" hazard.

Table A-2-a Per cent of marginal stand contributed by one sugar pine crop tree by present tree d.b.h. level of control cost, and intensity of rust hazard.

Average of Site I and II-167-1/2'-Managed Stand

This table to be used in evaluating stands where Site I and II are so intermingled that areas can not be readily separated by site. Values have been rounded off to the nearest whole number.

| Present tree d.b.h. (inches) | Level of control cost | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0-1.0 m.d./acre | | | 1.1-2.0 m.d./acre | | | 2.1-3.0 m.d./acre | | | 3.1-4.0 m.d./acre | | | 4.1-6.0 m.d./acre | | |
| | High | Med. | Low | High | Med. | Low | High | Med. | Low | High | Med. | Low | High | Med. | Low |
| -2 | 7 | 6 | 5 | 4 | 4 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 1 | 1 |
| 2 | 9 | 8 | 5 | 6 | 5 | 3 | 4 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 1 |
| 4 | 12 | 10 | 6 | 8 | 6 | 4 | 5 | 4 | 3 | 4 | 3 | 2 | 3 | 2 | 2 |
| 6 | 16 | 12 | 8 | 10 | 7 | 5 | 7 | 5 | 3 | 5 | 4 | 2 | 4 | 3 | 2 |
| 8 | 20 | 14 | 8 | 12 | 8 | 5 | 9 | 6 | 4 | 6 | 4 | 3 | 5 | 3 | 2 |
| 10 | 27 | 18 | 11 | 17 | 11 | 7 | 12 | 8 | 5 | 9 | 6 | 3 | 6 | 4 | 2 |
| 12 | 33 | 21 | 13 | 20 | 13 | 8 | 14 | 9 | 6 | 11 | 7 | 4 | 8 | 5 | 3 |
| 14 | 38 | 24 | 16 | 23 | 15 | 10 | 16 | 10 | 7 | 12 | 8 | 5 | 9 | 6 | 4 |
| 16 | 41 | 27 | 20 | 26 | 16 | 12 | 19 | 12 | 9 | 14 | 9 | 7 | 10 | 6 | 5 |
| 18 | 23 | 14 | 11 | 14 | 8 | 7 | 10 | 6 | 5 | 8 | 4 | 4 | 5 | 3 | 3 |
| 20 | 27 | 18 | 16 | 16 | 11 | 10 | 11 | 8 | 7 | 8 | 6 | 5 | 6 | 4 | 4 |
| 22 | 27 | 20 | 19 | 17 | 12 | 11 | 12 | 9 | 8 | 9 | 7 | 6 | 6 | 5 | 4 |
| 24 | 28 | 22 | 21 | 17 | 14 | 13 | 12 | 10 | 9 | 9 | 7 | 7 | 6 | 5 | 5 |
| 26 | 26 | 24 | 24 | 16 | 15 | 14 | 11 | 10 | 10 | 8 | 8 | 8 | 6 | 6 | 5 |
| 28 | 22 | 22 | 22 | 14 | 14 | 14 | 10 | 10 | 10 | 7 | 7 | 7 | 5 | 5 | 5 |
| 30 | 17 | 17 | 17 | 10 | 10 | 10 | 7 | 7 | 7 | 5 | 5 | 5 | 4 | 4 | 4 |

NOTE: In calculating the marginal rating of any stand, the aggregate percentage assigned to the larger trees must not exceed certain limits. These limits are as follows:

0-1.0 man days control cost: Not more than 40% in trees :
1.1-2.0 man days control cost: Not more than 25% in trees : 14" or larger on "Low" hazard.
2.1-3.0 man days control cost: Not more than 17% in trees : - 24" or larger on "Medium" hazard.
3.1-4.0 man days control cost: Not more than 13% in trees : 28" or larger on "High" hazard.
4.1-6.0 man days control cost: Not more than 9% in trees :

## Table A-3. Per cent of Marginal Stand Contributed by One Sugar Pine Crop Tree, by Present Tree d.b.h., Level of Control Cost, and Intensity of Rust Hazard (Site II-150—managed stand)

| Present tree d.b.h. | Level of control cost | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0–1.0 m.d./acre | | | 1.1–2.0 m.d./acre | | | 2.1–3.0 m.d./acre | | | 3.1–4.0 m.d./acre | | | 4.1–6.0 m.d./acre | | |
| | High | Med. | Low | High | Med. | Low | High | Med. | Low | High | Med. | Low | High | Med. | Low |
| (inches) | | | | | | | | | | | | | | | |
| −2 | 2.6 | 2.0 | 1.1 | 1.6 | 1.2 | 0.7 | 1.1 | 0.9 | 0.5 | 0.8 | 0.6 | 0.4 | 0.6 | 0.5 | 0.3 |
| 2 | 3.8 | 2.8 | 1.4 | 2.3 | 1.7 | 0.9 | 1.6 | 1.2 | 0.6 | 1.2 | 0.9 | 0.5 | 0.9 | 0.6 | 0.3 |
| 4 | 6.0 | 4.3 | 2.4 | 3.6 | 2.6 | 1.4 | 2.6 | 1.8 | 1.0 | 1.9 | 1.4 | 0.8 | 1.4 | 1.0 | 0.6 |
| 6 | 8.2 | 5.4 | 2.6 | 5.0 | 3.3 | 1.6 | 3.5 | 2.3 | 1.1 | 2.6 | 1.7 | 0.8 | 1.9 | 1.3 | 0.6 |
| 8 | 11.1 | 6.6 | 2.5 | 6.7 | 4.0 | 1.5 | 4.8 | 2.8 | 1.1 | 3.6 | 2.1 | 0.8 | 2.6 | 1.5 | 0.6 |
| 10 | 16.9 | 9.8 | 4.8 | 10.3 | 6.0 | 2.9 | 7.3 | 4.2 | 2.1 | 5.5 | 3.1 | 1.5 | 3.9 | 2.3 | 1.1 |
| 12 | 21.3 | 11.8 | 6.0 | 13.0 | 7.2 | 3.7 | 9.2 | 5.1 | 2.6 | 6.9 | 3.8 | 1.9 | 5.0 | 2.7 | 1.4 |
| 14 | 25.2 | 14.0 | 7.4 | 15.3 | 8.5 | 4.5 | 10.8 | 6.0 | 3.2 | 8.1 | 4.5 | 2.4 | 5.8 | 3.3 | 1.7 |
| 16 | 24.4 | 15.5 | 10.0 | 17.3 | 9.4 | 6.1 | 12.2 | 6.6 | 4.3 | 9.1 | 5.0 | 3.2 | 6.6 | 3.6 | 2.3 |
| 18 | 15.1 | 6.8 | 4.8 | 9.2 | 4.2 | 2.9 | 6.5 | 2.9 | 2.1 | 4.9 | 2.2 | 1.5 | 3.5 | 1.6 | 1.1 |
| 20 | 18.5 | 12.1 | 10.5 | 11.3 | 7.4 | 6.4 | 8.0 | 5.2 | 4.5 | 5.9 | 3.9 | 3.4 | 4.3 | 2.8 | 2.4 |
| 22 | 19.8 | 13.8 | 12.4 | 12.1 | 8.4 | 7.6 | 8.5 | 5.9 | 5.3 | 6.4 | 4.4 | 4.0 | 4.6 | 3.2 | 2.9 |
| 24 | 20.2 | 15.2 | 14.2 | 12.3 | 9.3 | 8.6 | 8.6 | 6.5 | 6.1 | 6.5 | 4.9 | 4.5 | 4.7 | 3.5 | 3.3 |
| 26 | 16.3 | 16.3 | 16.3 | 9.9 | 9.9 | 9.9 | 7.0 | 7.0 | 7.0 | 5.2 | 5.2 | 5.2 | 3.8 | 3.8 | 3.8 |
| 28 | 11.3 | 11.3 | 11.3 | 6.9 | 6.9 | 6.9 | 4.8 | 4.8 | 4.8 | 3.6 | 3.6 | 3.6 | 2.6 | 2.6 | 2.6 |

Note: In calculating the marginal rating of any stand, the aggregate percentage assigned to the larger trees must not exceed certain limits. These limits are as follows:

| | |
|---|---|
| 0–1.0 man days control cost: Not more than 40% in trees | 14″ or larger on "Low" hazard. |
| 1.1–2.0 man days control cost: Not more than 25% in trees | |
| 2.1–3.0 man days control cost: Not more than 17% in trees | 24″ or larger on "Medium" hazard. |
| 3.1–4.0 man days control cost: Not more than 13% in trees | 28″ or larger on "High" hazard. |
| 4.1–6.0 man days control cost: Not more than 9% in trees | |

STRIP NO. ---------- RUNNING ---------- FROM ---------- CH. ---------- PLUS ---------- CH. ---------- OF ---------- CORNER.

SUGAR PINE STOCKING DATA SHEET

STRIPMAN ---------- DATE ---------- T. ---------- R. ---------- SECTION ----------

FOREST ---------- BLOCK ---------- AREA ----------

| 5 CHAIN TRANS. | DBH | SUGAR PINES BY DIAMETER CLASSES - IN INCHES | | | | | | | | | | | | | | | | | | OTHER NON-CULL SUGAR PINES 11.0'' AND OVER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 35 | |
| | CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | REPLACE CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | POTENTIAL CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | CUT TO RELEASE PCT | | | | | | | | | | | | | | | | | | | | |
| | CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | REPLACE CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | POTENTIAL CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | CUT TO RELEASE PCT | | | | | | | | | | | | | | | | | | | | |
| | CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | REPLACE CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | POTENTIAL CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | CUT TO RELEASE PCT | | | | | | | | | | | | | | | | | | | | |
| | CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | REPLACE CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | POTENTIAL CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | CUT TO RELEASE PCT | | | | | | | | | | | | | | | | | | | | |
| | CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | REPLACE CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | POTENTIAL CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | CUT TO RELEASE PCT | | | | | | | | | | | | | | | | | | | | |
| | TOTAL CT / PCT | | | | | | | | | | | | | | | | | | | | |

156-85

REPLACE CROP TREE: INDICATE HERE BY SPECIES BELOW THE CROP TREE WHAT WILL REPLACE THE CROP TREE IF IT IS ELIMINATED BY BLISTER RUST. (INCLUDE HARDWOOD AND BRUSH.)

CUT TO RELEASE PCT: TALLY HERE BY SPECIES AND DBH DIRECTLY UNDER THE PCT, THOSE TREES WHICH MUST BE CUT TO RELEASE THE POTENTIAL CROP TREE.

STRIP NO. ---------- RUNNING ---------- FROM ---------- CH. ---------- PLUS ---------- CH. ---------- OF ---------- CORNER

| 5 CHAIN TRANS. | DBH | SUGAR PINES BY DIAMETER CLASSES - IN INCHES | | | | | | | | | | | | | | | | | | OTHER NON-CULL SUGAR PINES 11.0'' AND OVER. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | -2 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 36 | |
| | CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | REPLACE CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | POTENTIAL CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | CUT TO RELEASE PCT | | | | | | | | | | | | | | | | | | | | |
| | CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | REPLACE CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | POTENTIAL CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | CUT TO RELEASE PCT | | | | | | | | | | | | | | | | | | | | |
| | CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | REPLACE CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | POTENTIAL CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | CUT TO RELEASE PCT | | | | | | | | | | | | | | | | | | | | |
| | CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | REPLACE CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | POTENTIAL CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | CUT TO RELEASE PCT | | | | | | | | | | | | | | | | | | | | |
| | CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | REPLACE CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | POTENTIAL CROP TREES | | | | | | | | | | | | | | | | | | | | |
| | CUT TO RELEASE PCT | | | | | | | | | | | | | | | | | | | | |
| TOTAL | CT / PCT | | | | | | | | | | | | | | | | | | | | |

PC-141 (REV. 5-6-52)
155-R5

SUGAR PINE STAND EVALUATION SHEET

FOREST---------- DATE ---------- DELINEATOR ---------- T.---------- R.---------- SECTIONS ----------

BLOCK ---------- AREA---------- ---------- ACRES ---------- SITE --------- REMAINING BRC COST UN MD ---------- HAZARD ----------

YEAR LOGGED ----------

| SECTION NO. | STRIP NO. | STRIP ACRES | NUMBER OF SUGAR PINE CROP TREES AND PCT* BY DBH CLASSES - IN INCHES | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | -2 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 36 |
| | | | | | | | | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | | | | | | | | |
| TOTALS | | | | | | | | | | | | | | | | | | | | | |
| ONE CROP TREE AS % OF MARGINAL STAND | | | | | | | | | | | | | | | | | | | | | |
| TOTAL % OF SIZE CLASS | | | | | | | | | | | | | | | | | | | | | |

TOTAL STAND EVALUATION

| HAZARD | PERCENT | STRIP ACRES | SA x % | MARGINAL RATING |
|---|---|---|---|---|
| LOW | | | | |
| MEDIUM | | | | |
| HIGH | | | | |
| TOTALS | | | | |

TOTAL ACREAGE RATED ----------

---------- HAZARD EVALUATION

| | PERCENT | STRIP ACRES | % / SA | |
|---|---|---|---|---|
| TOTAL OF ---------- TREES | | | | |
| TOTAL OF ----------TREES | | | | |
| PERCENT OF MARGINAL STAND FOR THIS HAZARD | | | | |

REMARKS:

MAXIMUM PERCENTAGE IN LARGER TREES ALLOWED

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* CROSS OUT 'PCT' IF EXTENSIVE MANAGEMENT TABLE TO BE USED.

PCT - POTENTIAL CROP TREES

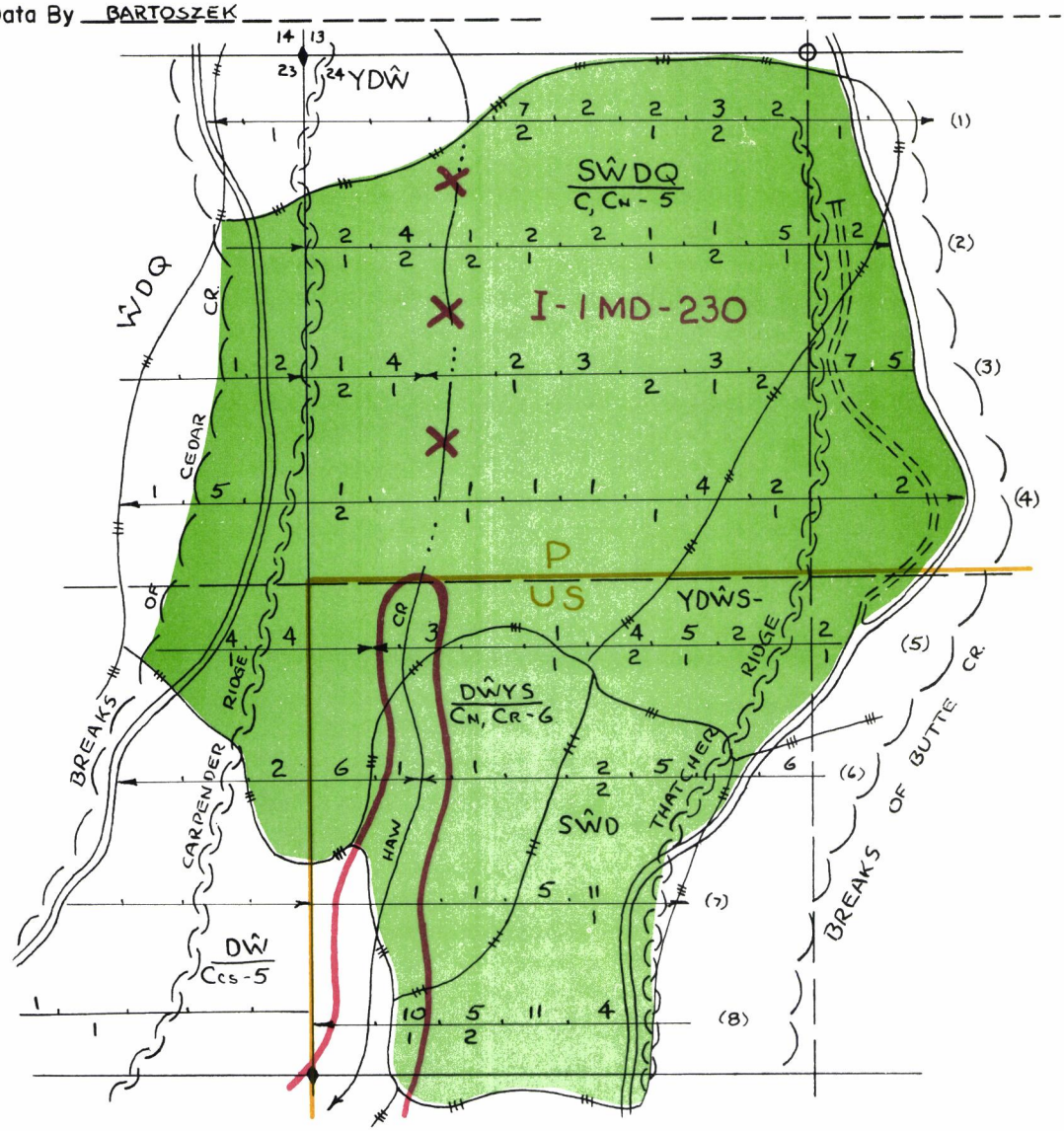
FORM FS-277-R5
(REV. 3-30-55)

# BRC SURVEY MAP

Unit CARPENTER RIDGE SUGAR PINE DELINEATION Map T. 25N R. 3E Sec. 23, 24

Drawn By BARTOSZEK Month and Year JUNE '52 Notes

Data By BARTOSZEK



## DELINEATION OF MATURE SUGAR PINE STANDS

There may be some difficulty in deciding whether a tree meets the requirements for a crop tree as compared with a potential crop tree, as the response to release afforded by logging often cannot be anticipated. This distinction is not material if the rating table based on crop trees plus potential crop trees is used. The classification should be made in the delineator's best judgment for purposes of recording the tally. Most trees which are neither crop trees nor potential crop trees may be recognized and eliminated on the basis of spacing or mechanical defect. In rating cut-over stands, some trees are eliminated from the crop tree and potential crop tree status because of their low growth rate as compared with other trees of similar size and crown class in the vicinity. Possibly these individuals may have severe competition from other trees. Since it appears likely that many of these trees may be released by removal of competing trees, they may be classed as potential crop trees in rating virgin stands.

The procedures below described will be used to delineate mature (virgin or risk cut) stands for sugar pine management.

### NATIONAL FOREST LANDS

In delineating virgin or lightly risk cut areas for sugar pine management it is desirable that the same methods used in rating cut-over areas be followed insofar as practical. This should enable a more uniform interpretation of the criteria and procedures used and should insure that all areas that will meet the requirements of the marginal rating are selected and delineated. Blister rust control, prior to the establishment of additional reproduction will be carried out on areas which qualify under the marginal rating, but will not be extended to other areas.

The same methods of ocular selection, mapping of boundaries and sampling for sugar pine and evaluating the areas for the marginal rating will be applied to virgin or mature stands as are used in cut-over or immature stands. Areas which have more than 20 per cent sugar pine by board feet volume and are site II or better will be the first areas delineated. These areas may frequently be located from existing cruises and maps made in connection with timber surveys. They

will be further subdivided on the basis of field examination, and sampling where necessary, into the following categories:

Class A

Stands which qualify under the marginal rating, scoring crop trees plus potential crop trees, using the marginal rating tables for managed stands.

Class B

Potential sugar pine management areas (those depending on getting sugar pine reproduction established). Stands not qualifying under marginal rating but having three or more sugar pine seed trees over 30" DBH per acre. (Timber survey cruise sheets, form 494, or examination of area will be the basis of this.)

Class C

Any stands that do not come under class A and class B above.

STATE AND PRIVATE LANDS

The lands having over 20 per cent by volume of sugar pine and which are site II or better will be delineated into three categories. These are:

Class A

Areas with sufficient understory of sugar pine to probably qualify under the marginal rating after the stand is cut. These areas may be selected using the same procedures as for immature stands or they may also be selected on the basis of a careful ocular examination. The area must have at least 25 per cent stocking of coniferous trees under 150 years of age, that is, Dunning's classes 1, 2, and 6 or younger. At least 10 per cent of these trees should be sugar pine. Suppressed trees should not be considered.

Reproduction counts should be made now and then to keep the ocular estimates in line. These may be done by sample strips or stocked

quadrats. This class should be mapped similarly to immature stands that qualify.

Class B

These are potential sugar pine management areas and are stands that are deficient in understory. They have less than 25 per cent stocking with less than 10 per cent pine. Stands not qualifying as class A but with three or more sugar pines over 30" DBH per acre are class B stands. The approximate size, shape, and boundaries of these stands should be mapped to a 2"=1 mile scale.

Areas of high site III (125 feet at 300 years and above) with 33 per cent volume of sugar pine and over-all costs of less than 2 man days per acre should also be mapped similarly to class B areas.

Class C

These are stands with over 20 per cent by volume of sugar pine which have less than 3-30" DBH trees to the acre and are deficient in sugar pine reproduction.

No particular effort should be made to map these stands, but they should be shown on the map with the class B stands when their existence is known.

# SUGAR PINE SILVICULTURE

## CROWN CLASS *

A designation of trees in a forest with crowns of similar development and occupying similar positions in the crown cover. Differentiation into crown classes is intended for application in even-aged stands and within the small even-aged groups in which the trees in an uneven-aged stand are often arranged. The following four crown classes are commonly recognized.

### Dominant

Trees with crowns extending above the general level of the crown cover and receiving full light from above and partly from the side; larger than the average trees in the stand, and with crowns well developed but possibly somewhat crowded on the sides.

### Codominant

Trees with crowns forming the general level of the crown cover and receiving full light from above, but comparatively little from the sides; usually with medium-sized crowns more or less crowded on the sides.

### Intermediate

Trees shorter than those in the two preceding classes, but with crowns extending into the crown cover formed by dominant and codominant trees; receiving a little direct light from above, but none from the sides; usually with small crowns considerably crowded on the sides.

### Overtopped

Trees with crowns entirely below the general level of the crown cover receiving no direct light either from above or from the sides. Syn. Suppressed.

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*From "Forest Terminology" 1950, pub. by the Society of American Foresters, Washington, D. C.

## CROP TREES

A tree selected in a young stand or plantation because of growth rate position, to be carried through to maturity. Growth of such trees is made the object of frequent thinnings or other cuttings.

Frederick S. Baker in "Principles of Silviculture" 1950, p. 72, gives the following definitions:

1. Dominant trees. The crowns of dominant trees rise somewhat above the general level of the canopy, so that they enjoy full light from above and, to a certain degree, laterally. Sometimes in even-aged stands, but far more often in imperfectly even-aged or reserve types of stands, the largest dominant trees, for lack of lateral competition from codominants, grow to be coarse, heavy-limbed, broad-crowned trees that are called wolf trees and are considered undesirable members of the stand.

2. Codominant trees. These are not quite as tall as dominants. Their crowns receive overhead light, but they may be hemmed in to a certain degree laterally by dominants. They are nearly as thrifty as dominants and with them comprise the main canopy of the forest.

3. Intermediate trees. These crowns occupy a definitely subordinate position and are subjected to sharp lateral competition from crowns of the two previous classes, although they receive some direct overhead light through holes in the canopy.

4. Suppressed trees (or overtopped). These are definitely submerged members of the forest community having no free overhead light worth considering. They exist by virtue of the sunlight that filters through the canopy or the skylight that may be received through some chance break. They are weak and slow-growing.

## THE CROP TREE CONCEPT

According to Dunning, about 40 per cent of the trees in a stand are dominant, but from this 40 per cent (in number) comes 90 per cent (in volume) of the yield at time of logging.

See Dunning, D.--"Forest Management, Field Discussion, Mixed Conifers, California, Spring 1949." Especially (p. 77) Dominants, and (p. 8) Crop trees.

A "crop tree" is expected to be a dominant at the end of the rotation, as well as at time of pine inventory survey.

A "crop tree," therefore, is a dominant from start (seedling) to finish (logged tree).

All predictions by the Vaux method assume the rapidity of growth of dominant trees. Some additional trees on any particular site may eventually end up as crop trees, but not in the same length of time. Such slow-growing trees are not crop trees in the strict sense as used here.

## SIZE AND NUMBER OF DOMINANTS PER ACRE

Depending upon age and competition, dominants may be of almost any size.

Given a constant per cent of stocking, the per acre number of trees and of dominants varies enormously with age (size).

See Dunning, D., and L. H. Reineke--"Preliminary Yield Tables for Second-Growth Stands in the California Pine Region." (USDA, Tech. Bull. 354) 1933, 23 pp., 6x9", illus., US-G.P.O.

See Quick, C.R. (Memo. to T.H. Harris, et al, 5/2/50). "Trees per acre in Sierran Mixed Conifer Forest." 1950, 6 pp., typed, 4 tables, BRC-D&I, Berkeley.

Consideration of most of the pertinent reported data is based on "full stocking," that is, on a dense uniform distribution of trees over the whole area concerned. At less than full stocking, however, spacing of "clumped" (unevenly distributed) trees is still of considerable importance.

## SUGAR PINE ECOLOGY VERSUS WHITE FIR ECOLOGY

Sugar pine is somewhat intolerant; white fir is tolerant. See Baker, F.S.--"A revised tolerance table." Jour. Forestry 47(3): 179-181, 1949.

The following ecological generalizations are believed to be valid.

1. Upon release from suppression, sugar pine is slower in recovery than is white fir.

2. Sugar pine is much more suppressed (handicapped) by shade and crowding than is white fir.

3. Sugar pine in relatively open situations will "release" after suppression by root competition from mature trees, but often this release is very slow.

Under normal conditions there appears to be a certain size--perhaps large poles--beyond which sugar pine outgrows white fir.

## SOME CONVENTIONS AND DIFFERENCES

For Dunning's "internode trend" we arbitrarily use length of last 5 years of growth for tree-to-tree comparisons of growth-trend and crop-tree expectations.

## USE OF AERIAL PHOTOGRAPHS

The delineation of sugar pine stands is a time-consuming process, and every means should be used that will accelerate and simplify the work without sacrificing accuracy. Aerial photographs of many of the areas being classified are available. These photographs are a source of information that is invaluable to the sugar pine delineator.

An area designated for aerial photo coverage is stripped with a series of adjacent flights flown at a near-constant elevation. The pictures are taken so there is about 60 per cent overlap on each consecutive photo and 30 per cent overlap on the photos taken on adjacent flights. This insures complete coverage of the area and furnishes photos on which stereoscopic studies can be made.

Each photo contains certain index information which usually appears at the north end of the print. In the upper left corner is the date when the photograph was taken, and in the upper right corner the agency symbol, the flight number, and the photo number are shown. This information is transferred to a 1/2"=1 mile photo-index map, which shows the flight lines and the position and number of each photo along the flight line in relation to standard map features. These maps may be obtained from the forest supervisor, and must be used when ordering photographs of any selected areas.

The scale of the photograph is determined by the altitude from which it was taken and the focal length of the camera. The most common photo scale for use in forested areas at the present time is 1:20,000. This is approximately 3.2"=1 mile on the photograph. At this scale the finished photograph is a 9-inch square contact print and shows an area of approximately 9 square miles.

Because of difference in elevation of datum, and uneven plane keel, there is a certain amount of distortion present on all aerial photos, the least amount being found in the center of the photo and the greatest amount being found on the outer periphery. For this reason the most accurate information will be found within the center 4 inch of each photograph, and the interpreter should restrict his studies to this area as much as possible. When it is necessary to interpret the information on the edge of a photo, it may be best to use photos from an adjacent flight or a combination of photographs from the two flights.

For best results the most recent photos available should be used. Photographs taken at the time the area was virgin timber are extremely difficult to interpret once the area has been logged.

It is also true that photographs taken immediately following a logging operation and used 10 years later will be misleading. For example, an area which appears bare on the photos may, on the ground, support a fair-to-excellent stand of reproduction after a lapse of 10 years. The same will hold true for photographs only 4 or 5 years old and covering well-stocked areas of good site. On the photograph the area may appear void of coniferous growth, because the trees are too small to be visible on the 1:20,000 scale photo. Trees under 10 feet in height are not readily visible on the photograph; therefore, frequent ground checks must be made when using photos that are older than a few years.

Caution should be exercised by the delineator to avoid over-interpretation--that is, relying on personal judgment in interpretations without making ground checks for accuracy. Maximum utilization of aerial photographs stems from stereoscopic study of the photos coupled with frequent field inspections. Therefore, it is absolutely essential that periodic checks be made if accuracy is to be maintained.

## DELINEATION OF NONPRODUCTIVE AREAS

One of the most common uses of aerial photographs in sugar pine delineation work is in defining the extent and location of brush fields, barren

areas, meadows, and other nonproductive areas. These areas should be delineated on the photographs prior to field work and quite often can be eliminated from further consideration, thereby avoiding the time and expense of running strips through obvious nonproductive areas.

## DELINEATION OF POORLY STOCKED AREAS

Another use of aerial photographs is in the delineation of poorly stocked areas. In sugar pine delineation studies, areas supporting less than 20 per cent stocking in coniferous growth are frequently eliminated from further consideration. Often by eliminating poorly stocked areas it will be found that strip samples need be taken on only a small part of the area being considered. However, before any poorly stocked area can be eliminated from further consideration, the interpretation must be verified by a ground inspection, and a final decision reached. Lightly stocked areas with a high percentage of sugar pine trees may qualify.

## DELINEATION OF TYPES IN THE FIELD

An area, known to contain some sugar pine, is selected for pine delineation in order to determine the boundaries of the sugar pine type and the amount of the sugar pine reproduction present.

## FIELD USE OF AERIAL PHOTOGRAPHS

When the type map maker has learned to interpret the information on the photos, typing in the field becomes a relatively simple process. The recommended procedure follows:

### Nonproductive Lands

Eliminate from consideration nonproductive areas and areas of poor stocking as described above, and with further study determine the extent and location of the main bodies of timber and the best approach from a typing standpoint. When this information has been assembled, field typing can be started.

### Type By Drainages

It is best to type by logical units, that is, areas of homogeneous type composition. Type boundaries may be recognized on the photograph by

two distinguishing characteristics: (1) change in color tone, and (2) change in density. With the photographs these features are readily identifiable in the field and the starting point for typing is readily ascertained.

Except where land ownership may be the deciding factor in setting unit boundaries, the type mapper should not attempt to work the areas by sections. It is more feasible to type by drainage basins or homogeneous timber blocks.

In areas where sugar pine type is more or less restricted to drainages a definite method of typing presents itself which should be adhered to for greater accuracy and speed. The delineator selects a starting point on the photograph where there is a change in color tone and density for the unit in question and proceeds to that point in the field. By field observations he determines the species composition at this point and enters the corresponding symbols and type line on the photograph. Once the species composition has been determined it usually can be traced on the photos by a line which separates either color tone or density or both. However, in order to verify the type boundary it becomes necessary to walk up each drainage and check or type irregularities which are not readily visible on the photograph.

In relatively narrow drainages it is often possible to walk up one side, and by carefully studying the photographs, type both sides at the same time. With the aid of field glasses wider drainages may be classified in the same manner. In both instances consult the photograph and select a course to take advantage of the vantage points available while en route. If the type boundary cannot be distinctly determined, both on the ground and on the photograph, the delineator should examine the area more thoroughly. Hazard lines are often determined in the same manner and at the same time the type boundaries are set and quite often the two will coincide.

## Hazard Lines

The only hazard lines which are delineated on the photographs are those of low hazard. It is assumed that all types along drainage courses will be either high or medium hazard. A sugar pine type boundary may extend into low hazard and, either because of the site or ribes pattern and composition, may not require eradication work. Therefore, it should be remembered that all sugar pine type, regardless of hazard, is to be delineated.

## Color Symbols

Colored pencils are used in marking the various types of information on the photographs. The following are the recommended pencil colors and their uses.

Red (Eagle) #877 for all type boundaries or Lake Red (Dixon) #326-1/2.
Green (Dixon Best) #352 for low-hazard boundaries.
Yellow (Dixon Best) for all drainages, (Dixon Best) #353.
Blue (Dixon Best) #350 for section lines.

Be consistent. Do not substitute one color for another for any one feature. Such practices will only lead to confusion and misleading information in the final analysis.

## Location of Section Corners

With such information as type and hazard lines on the photographs it becomes necessary to tie this information to a public land survey. This can be done if the delineator, while in the field, will locate the section corners and prick them on the photos. Many of the corners in cut-over areas will be fairly easy to identify on the photos and can be pricked within from one to three chains of their true location, if care is taken.

Corners located in virgin timber are difficult to plot in their true position, even by the most experienced interpreter. However, by the recognition of cultural features, type irregularities, and such individual characteristics as snags, fallen trees, and other nearby land marks, section and quarter corners may be pricked with considerable accuracy.

Extreme care should be taken in pricking corners on the photos, and the worker should be sure of his location before doing so, for it must be remembered that other people may wish to use the photographs, and incorrect information is worse than none at all. A corner plotted incorrectly will naturally throw the shape of the section off. The more section corners pricked on the photos the more accurately can type and hazard lines be tied to the public land survey. Where a known section line crosses some cultural feature that is easily recognizable in the photo, the location should be noted on the photo.

## ADVANTAGES IN USING AERIAL PHOTOS

There are many advantages in using aerial photographs. With the aid of a stereoscope the mapper obtains a clear, 3-dimensional view of relatively large acreages of land, and he is able to see drainage systems, ridges, roads, other topographic features and types in their true relation to each other. By recognition of ground features the mapper can tell precisely where he is at all times without the aid of compass or pacing. By consulting the photos he can select the best routes between vantage points that will allow him to type accurately.

In addition the experienced interpreter can determine the hazard lines and usually delineate stands at uniform age and density. He can occasionally outline areas which support good sugar pine and delineate some fir, ponderosa, or lodgepole stands and eliminate areas so poorly stocked that no additional field work will be required. The areas which will require sugar pine tally strips can be delimited. Depending upon the type of country, the terrain, and the accessibility of vantage points, the experienced mapper can cover from 300 to 1,000 acres per day.

The use of aerial photographs in sugar pine delineation work does not imply that all the many problems can be easily solved by using the photos. Much detailed ground work still must be done. It should be borne in mind that there are many things which cannot be determined from photographs, even when combined with ground checks, but when they are used to their greatest capacity, aerial photographs can be a time-saving tool well worth the time and effort expended on them.

# SITE CLASSIFICATION

Site index or classification is an attempt to evaluate the total productivity or over-all capacity of a site. It is not necessarily an index to growth of trees on the area at any particular time. Site index is considered to remain the same before and after logging or even after fire, as long as there is no physical loss of soil by erosion. The site index will be determined by the chief of party.*

## NEED FOR SITE DETERMINATION

To make an accurate evaluation, site should be determined as accurately as possible. The marginal score will be greatly in error if the wrong site classification is used. In any case, site classification may be obtained from forest reappraisal or condition maps. Data from these maps should be compared with topographic features and exposure. The reappraisal and forest condition maps are on a small scale (1/2" and 1"=1 mile) and thus may give only a general over-all picture of the site. For this reason site may need to be determined in the field for small homogeneous blocks where these maps are not too accurate.

## BASIS

Site classification is based on the height-age relation for dominant trees of one or more of the four species--ponderosa pine, sugar pine, Douglas fir, and white fir. Incense cedar is not to be used in determining site class.

The site range is divided into 6 classes represented by 25-foot intervals of average total tree height of dominants at a reference age of 300 years. (The 300-year reference was chosen because variance in height was slight after reaching this age. Height-age curves for the 4 species are extremely variable in form through the early age classes including 50 and 100 years.) This site classification scale divides the range in productive capacity due to site by equal difference in the height-age curves.

*Site classification is taken by and large from "A Site Classification for the Mixed-Conifer Selection Forests of the Sierra Nevada" by Duncan Dunning, senior silviculturist of the California Forest and Range Experiment Station, Berkeley, Calif. Research Note No. 28, December, 1942.

The site classes are designated from best to poorest--A-200, I-175, II-150, III-125, IV-100, and V-75. The curves on succeeding pages define the mid-lines of the site class zones.

## NUMBER OF INDICATOR TREES

In small areas where site appears to have but little variation, a sample of 1 to 3 trees should be enough to determine the site within a reasonable degree of accuracy. (The older the age class, the fewer the number of samples needed.)

When sampling large areas, California Forest and Range Experiment Station Research Note No. 28 should be consulted.

## CHOICE OF TRUE DOMINANTS

The sample trees should be true dominants. If the Region 5 tree classification is followed the sample trees used should be from crown classes 1, 3, or 5.

## SAMPLE TREES MUST HAVE BEEN DOMINANT THROUGHOUT THEIR LIFE

If a tree core shows suppression during some period, particularly in its youth, the tree was probably not dominant from its youth and hence should be discarded as a sample.

Much depends upon the choice of proper trees. If trees other than true dominants are selected, the site determination may be greatly in error. On cut-over lands where few, if any, true dominants are left and no previous site determination is available, a good guess at site is often better than determinations based on unsatisfactory trees.

One should be cautious in the use of reproduction to determine site class. Extreme care should be used to assure that no stagnated or repressed saplings are selected for data. It is unwise to classify site on forest second-growth less than 70-80 years of age. Thus, the family of curves in the upper left graph in Research Note No. 28 is apparently never used in the field.

Trees with normal undamaged tops should be selected for the sample height measurements. The choice need not be restricted to trees with pointed crowns. Older round or flat-topped trees are admissible where

the condition results from natural decline in height growth rather than from forking, breakage, or mistletoe and insect damage.

## AGE AND HEIGHT MEASUREMENTS

Where practicable, the site class can be determined while felling is in progress so that age counts on the stumps and the corresponding height measurements on the larger trees can be made without having to use either the increment borer, hypsometer, or Abney.

When ring counts cannot be made from stumps, an increment borer is used to determine age. For trees 100 years old or younger, the radii will fall within the span of the increment borer except on the best sites. For the larger trees, counts from the longest cores attainable may be supplemented with estimates for the remaining sections of radius. This will involve attention to such details as measuring diameter, single bark thickness, and core; calculating the remaining section of radius; estimating the rings therein; and adding estimate and core count.

Age counts from borings at breast height must be converted to total ages by adding the number of years required to grow to the height of 4.5 feet. The time varies from about 6 to 16 years according to site, but to make a variable adjustment would require an undesirable preliminary estimate of site quality itself. It would seem least prejudicial to the final estimate if a constant conversion factor, such as 10 years, were added. Age should be determined to the nearest 5 years.

Formula to be used to determine age of trees with radius greater than the span of the increment borer:

$$\text{Rings on core} + [(\text{rings, innermost inch}) \times (\text{Radius} - \text{length of core})] \div 10 = \text{total age}$$

When refinements are not advisable, where the timber is very large, or where for other reasons estimates of age must be relied upon entirely, indicator trees should be favored that are near the reference age of 300 years. At that age errors of -20 to +50 per cent in age will not materially affect the site classification.

In cut-over areas residual trees may be used to determine site. Indicator trees should be favored that are near the reference age of 300 years. In some instances it may be possible to correlate tops with

stumps as a measure of height. Age may be determined from a ring count of the stump.

Height measurements should be made within the reasonable limits of instrumental error--perhaps about 2 per cent. This can be accomplished easily with the Abney level and tape.

Use good judgment in site measurements. Do not rely blindly on growth measurements alone if they do not check with what seems reasonable.

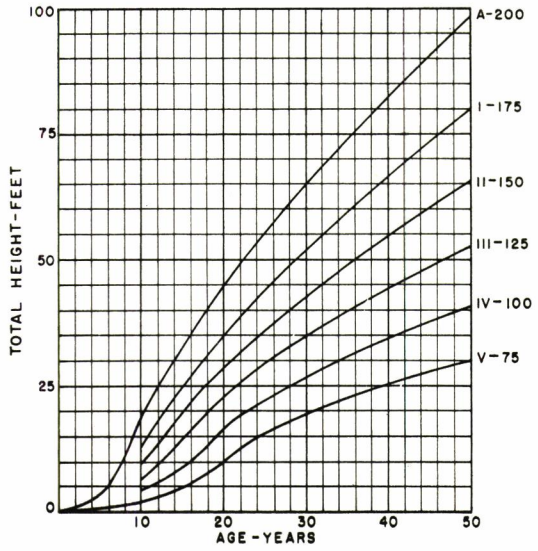



FIG. I
Res. Note No. 28

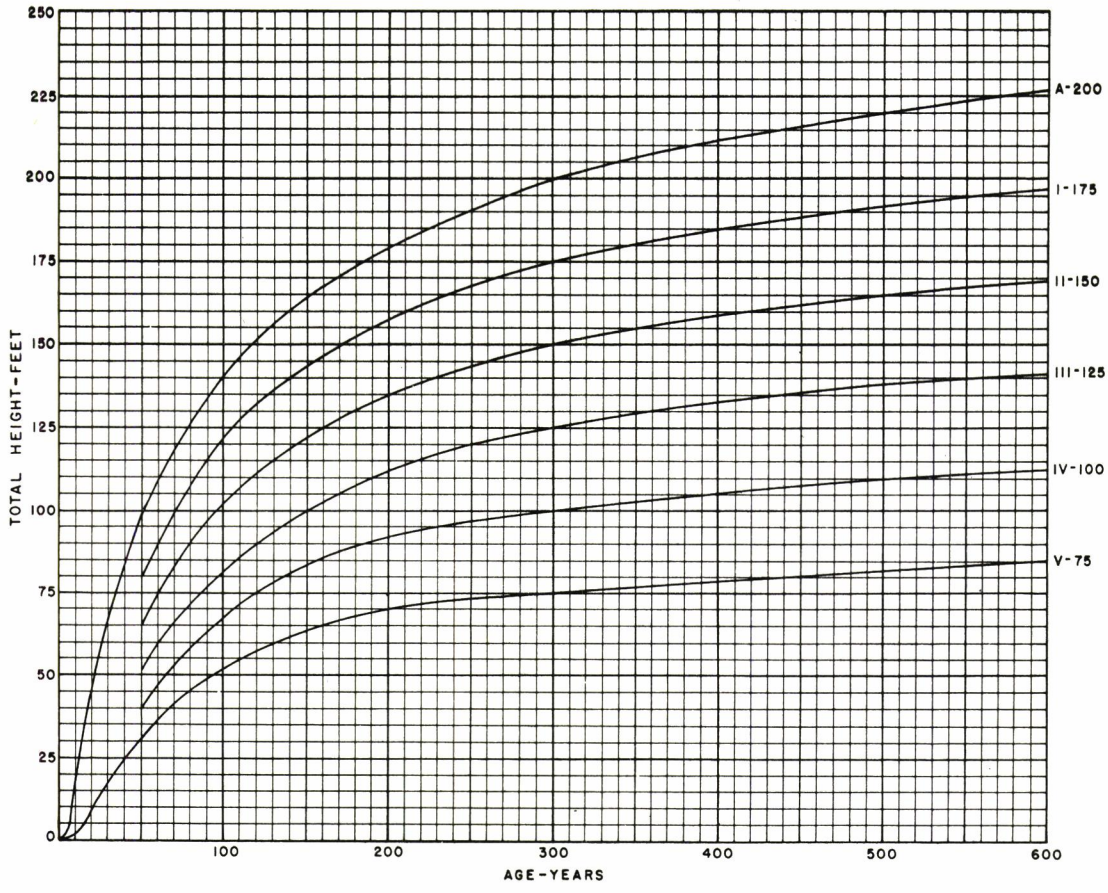
A SITE CLASSIFICATION FOR THE MIXED CONIFER SELECTION FORESTS OF THE SIERRA NEVADA
1942

Duncan Dunning

CALIFORNIA FOREST & RANGE EXPERIMENT STATION

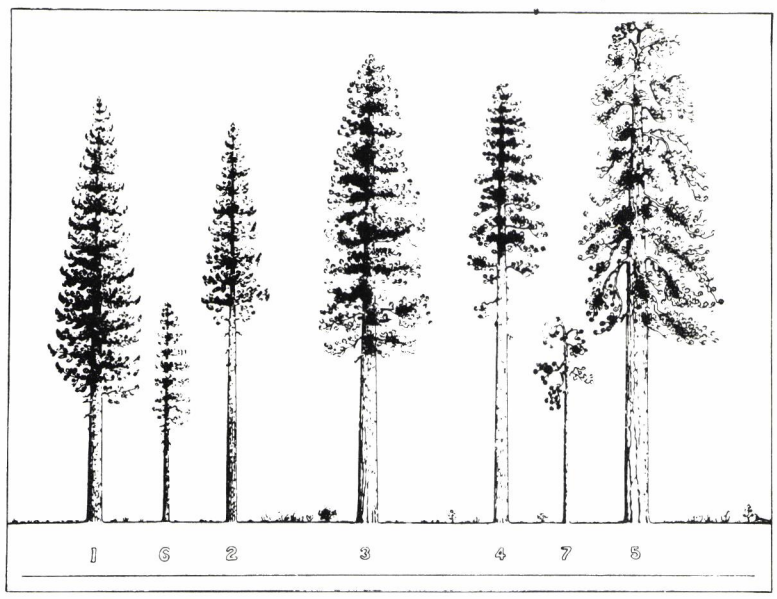
M. W. Talbot, Acting Director

Forest Service
U.S. Department of Agriculture



## DESCRIPTION OF DUNNING'S TREE CLASSES

| Item | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Age Classes (Approximate) | Immature-Thrifty (60-150 Yrs) | Immature-Thrifty (60-150 Yrs) | Thrifty-mature or mature (150-300 Yrs) | Mature (150-300 Yrs) | Over-Mature (Over 300 Years) | Immature (60-150 Yrs) | Mature and Over-mature (Over 150 Years) |
| Position | Isolated or Dominant | Usually Co-dominant | Isolated or Dominant | Usually Co-dominant | Isolated or Dominant | Intermediate or Suppressed | Intermediate or Suppressed |
| Crown lengths (Approximate) | 65% or more | Up to 65% | 65% or more | Up to 65% | Any length | Usually short | Usually short |
| Crown width | Average or wider | Less than Average | Average or wider | Less than Average | Any width | Any width | Any width |
| Seed bearing capacity | Fair | Poor | Very good | Greatest insect risk Fair to Good | Very good | Very poor | Poor |
| Form of top | Pointed | Pointed | Rounded | Rounded | Flattened | Pointed Rounded | Flat |
| Vigor | Good | Good-Moderate | Moderate | Moderate-Poor | Poor | Moderate-Poor | Poor |
| Diameter (Approximate) | Rarely over 30 inches | Up to 24" | 18" to 40" | Except for the small, poorly developed crown, smaller size, and lower vigor, similar to Class No. 3 | Largest Trees | 12" to 16" | Rarely over 18" |
| Bark | Dark; Ridges or small plates | Dark; Ridges or small plates | Light brown or yellow; mod. large plates | | Light yellow; wide, long smooth plates | Dark and rough ridged | Light yellow; thin and flat |
| Foliage | Rich green, dense, needles long and coarse | Rich green, mod. dense, needles long and coarse | Lighter green than #1, mod. dense; shorter than #1 | | Pale green, thin, tufty on ends of twigs | Not so dense as #1 and #2 | Very thin |
| Annual whorls | Distinct except on lower crown | Less distinct than #1 | Nodes indistinct, branches horizontal or drooping | | Branches drooping, gnarled and twisted, top flat | Internodes short | Indistinct, Branches few, and gnarled and drooping |
| | | | | | | | |
| Risk | Good | Good | Fair to good | Poor to fair | Poor | Fair to good | Poor |



# BILTMORE SCALE

A convenient Biltmore scale can be made from a folding rule or a 6-foot steel tape by marking it as indicated in the table below.

| Diameter | Distance from Zero End of Scale | Diameter | Distance from Zero End of Scale |
|---|---|---|---|
| 6 | 5 - 7/16 | 24 | 17- 3/16 |
| 8 | 7 | 26 | 18- 7/32 |
| 10 | 8-15/32 | 28 | 19- 1/4 |
| 12 | 9-14/16 | 30 | 20- 7/32 |
| 14 | 11- 1/4 | 32 | 21- 7/32 |
| 16 | 12-17/32 | 34 | 22- 5/32 |
| 18 | 13-12/16 | 36 | 23- 1/16 |
| 20 | 14-15/16 | 38 | 23-31/32 |
| 22 | 16- 3/32 | 40 | 24-13/16 |

Scale is designated for a reach of 25 inches and must be used 25 inches from the eye.

The tape may also be used in determining circumference. Conversion from circumference to diameter is given in the following table.

| Circumference in Inches | 2-Inch Diameter Class | Circumference in Inches | 2-Inch Diameter Class |
|---|---|---|---|
| 0 - 9-3/8 | 2 | 40-7/8 - 47-1/8 | 14 |
| 9-3/8 - 15-3/4 | 4 | 47-1/8 - 53-3/8 | 16 |
| 15-3/4 - 22 | 6 | 53-3/8 - 59-5/8 | 18 |
| 22 - 28-1/4 | 8 | 59-5/8 - 66 | 20 |
| 28-1/4 - 34-5/8 | 10 | 66 - 72-1/4 | 22 |
| 34-5/8 - 40-7/8 | 12 | | |

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